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FOR ALL WORKMEN, PROFESSIONAL AND AMATEUR.

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A COMBINATION BEDROOM SUITE.

BY J. SCOTT.

"CLEANLINESS is next to godliness." This is an acknowledged fact; but it is curious to note the relative proportion one bears to the other in the estimation of certain peoples. The Arab, for instance, is noted for his godliness, and is equally noted for his dirtiness. Whether this is to be accounted for by the absence of the—to us—necessary utensils in his possession, I will not venture to say. Certain it is that we have advantages over the Arab and his brethren, and this, I suppose, is one particular reason why we can boast that we are a cleanly as well as a godly people.

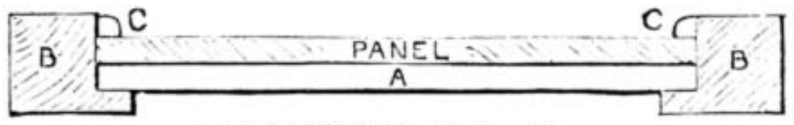

Fig. 1.—Section of Glass Door.

The advantages above mentioned it is needless to speak of; my object in mentioning them was to show that there is at least one among us—and that is myself—who is not satisfied with even the present obtainable conveniences, for the reason that, being a bachelor, and having but one room, I have not sufficient space for a complete bedroom outfit.

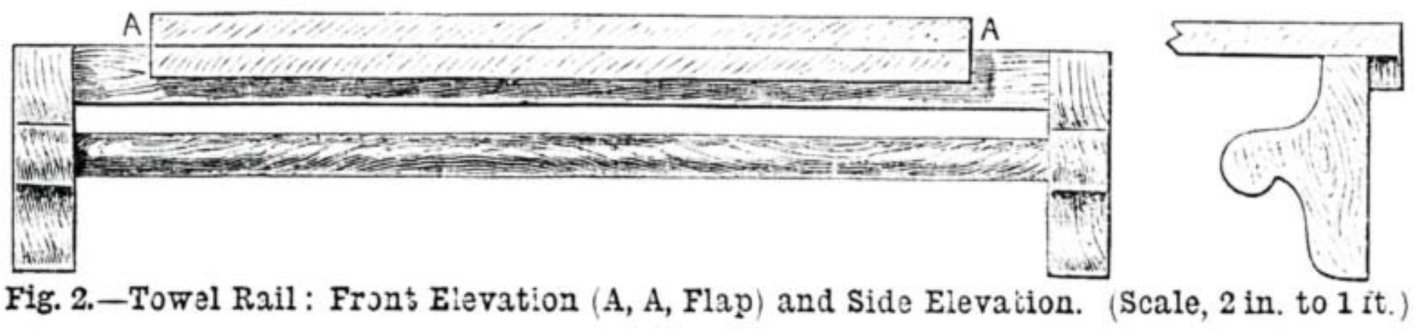

Fig. 2.—Towel Rail: Front Elevation (A, A, Flap) and Side Elevation. (Scale, 2 in. to 1 ft.)

As will be seen by a glance at my drawings, my aim is to combine all the uses of an ordinary bedroom suite in a

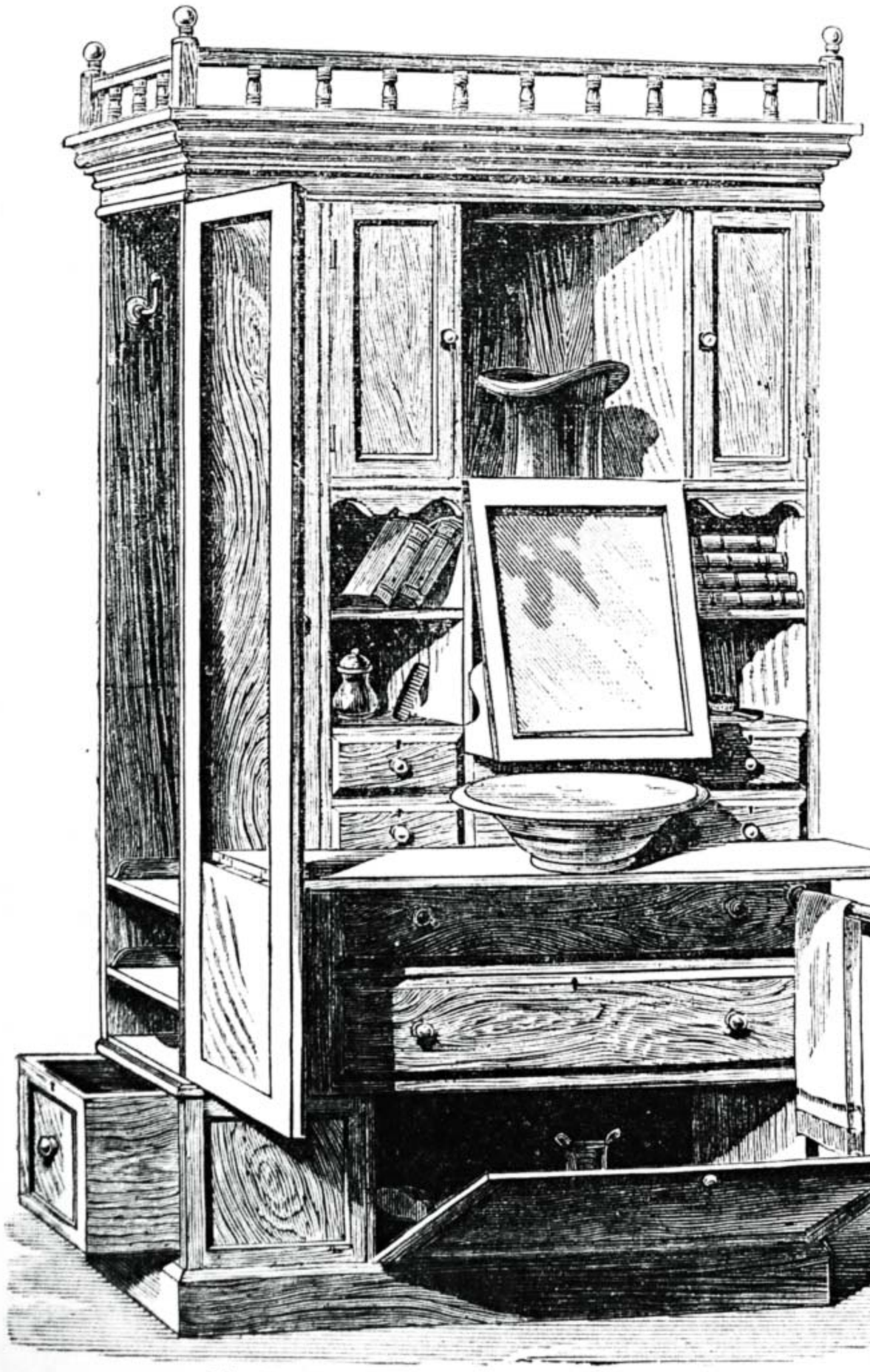

Fig. 3.—Suite Open.

Fig. 4.—Suite Closed.

A Combination Bedroom Suite.

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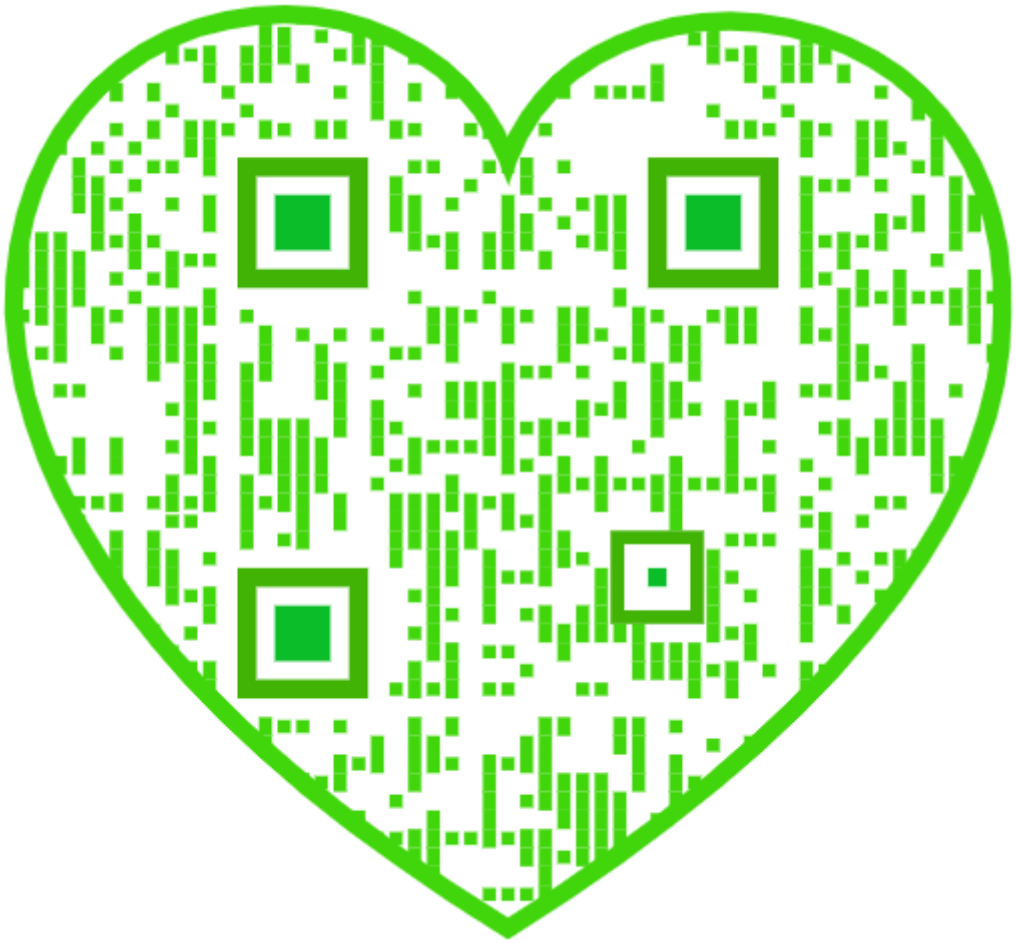

single article of furniture; and I think I may safely say that I have succeeded in doing so.

Presuming that I am addressing the amateur reader, I will now proceed with measurements. As I have drawn Figs. 3 and 4 to ¾ in. scale, professional workmen will know that that is sufficient for them. The job, when closed, occupies the space of twenty inches from the wall, and is 3 ft. 7 in. wide. Even in a very small room this will not be found inconvenient. When required for the purposes of a washstand, the long door on the left-hand side is opened, and the flap, which is part of the door panel, is let down; the towel rail is then brought round, and forms a support for the flap. Along the top of the flap is glued a strip of wood, which prevents it from slipping off the towel rail. The advantage of having the door and drawer to open at the side will be readily seen. Required as a dressing table, the door of the centre cupboard at the top is let down; and being fitted with a glass inside, and having a shaped piece of wood outside, to keep it at a slight angle, it forms a handy toilet mirror.

In making, care should be taken to get the pieces firmly joined together; and I should advise the amateur to get it cut out and fitted together before gluing, as it can undergo any necessary alterations, and can be glued up afterwards.

It is not my purpose in this paper to give any instructions on joinery, as I suppose that the reader has a sufficient knowledge of that craft. The wood should be ½ in. thick. Beginning with the plinth, *i.e.*, the bottom part, get two pieces of wood, each 3 ft. 7 in. long, and two pieces each 20 in. and 4 in. in depth; firmly join them together, and fix two or three thicker pieces in the space between at half an inch from the top to support the whole weight of the job. Very great care must be taken with this part, as the slightest mismeasurement will throw the whole job out of the square; or else prevent it from fitting exactly. It matters little whether the supports mentioned above are joined in lengthways or crossways, providing they are properly fixed. The edge all round the plinth should be canted slightly, as is shown in Figs. 3 and 4.

Proceeding with the side drawer and bottom cupboard, the top and bottom boards should be 3 ft. 6 in. long, and 19 in. wide; the two pieces forming the sides of the cupboard 12½ in. by 19 in.; and the piece in front, forming the side of the drawer, 12 in. by 12½ in.; whilst the back board is 3 ft. 7 in. by 12½ in. The drawer and cupboard door can then be made accordingly. A moulding should then be glued round the top, leaving half its depth free to receive the top carcase. When all is cut out, the bottom carcase should be glued into the plinth, thus hiding the thickness of the bottom board.

We now come to the top carcase. The back should be made up of boards firmly joined together; these separately may be of any width, providing that collectively they are 42 in. in width. A bottom and a top board, 19 in. by 33 in., should be fitted to the back board. Then a board, 58 in. long and 19 in. wide, should be fixed at the right-hand side, between the top and bottom; whilst another of the same dimensions is put between them at 32 in. distance from it towards the left-hand side. Next, the board forming the side of the long cupboard should be placed in its position. This board is 9 in. by 58 in.

We now have our top carcase ready to have its inside fed. We have four boards, each 32 in. by 18½ in., to fix. One at 7 in. from the bottom, another 6 in. above it, the next 9 in. above that, and the last 16 in. above that. These boards would be sufficiently firm, I think, if they were nailed or screwed in. The width of the top centre cupboard is 14 in.; the height 18 in. The two side cupboards are the same height, and 8 in. wide. The smaller cupboard underneath is 13 in. by 16 in. The jewel drawers should each be 4 in. deep.

I think I have now given sufficient measurements concerning the top carcase; the main thing is to get the big boards exactly fitted, the smaller ones can then be worked accordingly. If it is exactly joined and fitted it will now fit perfectly into the bottom carcase. These should not be glued together, as, in case of removal, it will be found convenient to have the job in two or three separate pieces.

The cornice is the next part to deal with. After having procured the moulding, mitre it up on three sides, to fit partly over the frieze, to which it should be glued. Proceed with the frieze in the same manner as with the plinth, using the same measurements, with the exception that the frieze is 2⅓ in. deep, taking care to get the inside cross pieces exact. A small beading might be glued round the bottom edge of the frieze.

If the Early English simplicity of the spindle rail on top is not admired by the maker, a pediment can easily be cut out to suit his taste, and should be glued along the moulding.

Having got the skeleton of our job together, the drawers and doors will next occupy attention. I need not say much of the drawers; they should have a beading glued round their fronts; otherwise, if they are bevelled, they will prevent the towel rail from carrying out its purpose.

Make all the door stiles 2 in. wide.

The full length of the side cupboard door should be 58 in.; the width 18 in. The movable panel must be 42½ in. long. This extra ½ in. allows for the strip of wood to be glued along the top, as before spoken of. The fixing of the towel rail (Fig. 2) should be left until the last, as it can then be screwed on at its proper height. It must be hinged on only to the front.

We will now look at the door containing the glass. I think an ordinary picture frame will explain the method to be adopted. Fig. 1 will give a sufficient idea of it. The glass, A, is fastened on B, the panel is then put in, and a moulding, C, is glued round the edges.

I have placed the cupboard on the left-hand side, so as to allow of a free movement of the arm of the person making use of the article as a washstand. If required, a cupboard could also be placed at the right-hand side; and I would be pleased to answer any inquiries concerning it through "Shop." Brass handles, or knobs, can be used. A handle must be placed somewhere along the flap, as shown, to keep it in its position as a panel of the door.

The two trays shown in the long cupboard should be made to slide in and out freely; and should each consist of a bottom piece 18 in. by 8½ in., with back and sides of 1½ in. depth.

Four pieces of wood should be screwed into the cupboard, two on each side, to allow for the introduction of the trays.

For finishing off the job I should advise it to be painted in some kind of enamel; there is at present in the market a very pretty and, I think, good enamel suitable for such purposes. Of course the inside parts can be stained. I think that if it were painted in some light colour it would relieve the heavy square appearance which seems to pervade it.

If my instructions are carried out, a firm and substantial article of furniture will be the result.

If any one should deem it worth a trial to make one of these wardrobes, I should be very pleased to hear of his success, through the ever-interesting columns of "Shop."

Such a job as is here described would, I think, be a very saleable article, especially at the present time, for the furnishing of small rooms at the seaside, etc., where space is important; and would, I think, repay the time and cost if one or two were made by a professional workman.

It will very likely be said by some of my professional readers that it is possible to purchase a complete bedroom suite almost as cheaply as it would cost to make one of these robes; but they must remember that space, and the convenience of putting it to the several uses named, was my motive for designing it.

Of course the back boards could be made of thinner stuff, and where the drawers fit in, a narrow framing would answer the purpose; but I should advise it to be made solid throughout, and of the same thickness.

It is quite unnecessary to have the backs, sides, and bottoms of the drawers as thick as the fronts—these could be made of much thinner stuff.

The method also that I have given of making the plinth and cornice varies also from the usual method, but made after the style that I have described they would be very firm.

I give no instructions as to panelling the doors and drawer fronts; I suppose this to be understood.

It will be observed that I have given all my measurements so as to allow for each board to be joined to its fellows in a strong manner. If it is the intention of the maker merely to nail the job together, he must first study my measurements, so as to reduce some of them accordingly.

POLARISATION OF LIGHT AND POLARISCOPES.

BY O. BECKERLEGGE.

The Construction of the Polariser.

In constructing instruments, we may avail ourselves of more than one method, or material, without vitiating the results. For example, we may use reflected light for our analyser, and for the reflector we may avail ourselves of glass, crystals, polished wood—preferably mahogany—or the clear, blue sky; indeed, anything that will reflect light, except metals. With any of these, we may use a Nicol prism for the analyser, or films, or plates of glass, the result in the main being the same. On the other hand, we may use a Nicol prism for the polariser, and a reflector for the analyser. This latter arrangement, however, would present so many mechanical difficulties if applied to microscopic work, as to render it practically impossible; though for simple demonstration it might be used well enough.

In 1808, M. Malus, a young man of philosophical mind, experimenting with a piece of Iceland spar, directed it towards a beam of light reflected from the windows of the Luxembourg Palace, and, to his surprise, found it to be polarised. Further experiments not only determined the polarising angle for

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glass, but showed that each reflecting substance had its own particular polarising angle. In describing methods I shall have nothing whatever to say in reference to constructing a Nicol prism, beyond the fact that a rhomb of Iceland spar is cut in two in the direction already indicated. This must be done by a lapidary's slitting disc, or wheel. The surfaces are then ground perfectly flat, polished, and cemented together with Canada balsam. I confess that in my hands the polishing has been a failure. Others with more mechanical skill may certainly do it; but I would not advise an amateur who is fortunate enough to possess a piece of spar pure enough to make a prism to attempt making one. I believe small prisms can be purchased unmounted for about 10s. per pair. At the same time, it must be fairly understood that a pair of Nicol prisms will give better results than the mode I am about to describe. But there are other considerations. If one goes the right way to work, the glass method will cost nothing like the money which a Nicol would cost; and what to the young philosopher is of infinitely more value, *he can make it himself*. The writer's experience is, that far more pleasure and instruction are gained by working out details, grappling with difficulties, and overcoming them or finding the solution, than in purchasing an instrument, the construction of which is a mystery, and using it on lines laid down by some one else, the reason of which you do not see.

We will begin with the polariser. As it has already been stated, this may be made as a reflector. Make a cell similar to the one holding the mirror of the microscope, but at least 1 in. deep. Now, it is true that a single plate of glass will polarise light, but only a portion will be reflected; another portion will be transmitted. This being so, we must have several sheets, or plates; each one will reflect a portion transmitted to it, so that by employing, say, six or eight plates, we shall practically reflect the whole of the light under polarised conditions. Perhaps a larger number than this may be required. We must have the required number of plates cut out of the same sheet, which must be of the thinnest and whitest window glass possible, and free from specks and flaws. On the bottom of the cell lay a piece of black cloth, or velvet, and the plates of glass on it. Some experimenters recommend the plates to be separated from each other by bits of paper being gummed at the corners. I have tried the plan in experimenting, but I confess in my hands it made no perceptible difference. If a stout brass wire ring is sprung into the cell on the glass, the plates will be retained in their place; the cell can be japanned or lacquered, and be fitted to swing in the gimbal that usually holds the mirror. If there be a difficulty in procuring circular plates of glass, then let the cell be made square, and in any village a glazier can be found to cut glass square. When this polariser is used with the analyser, place a slide, mounted with selenite, on the stage, and turn the reflector at such an angle as shall produce the highest colour in the selenite; that will be the best angle to employ. A little practice will enable one to catch it very readily. It should be as near as possible 58°.

I will now describe the method for using transmitted light; and as the principle will be the same for both polariser and analyser, I shall simply describe the details of one.

In the eye-piece of the microscope which I described in WORK, it will be seen that I have drawn the cell containing the field lens to extend considerably beyond the lens. Now, if one is desirous of making the instrument as complete as possible, a thread should be chased on the inside of the projecting cell. Procure a piece of brass tube of the size that when a thread is chased on it, it will screw into the eye-piece. It can, of course, be made a tight fit, and so dispense with the screw. Next prepare a square block of wood, say 6 in. long, and of such a size that when rounded it will slip into the tube. On its two opposite sides draw a line at an angle of 26°. (See diagram Fig. 3.) Cut down to the line, and leave the wood as an acute wedge. The edges must now be planed off, and the wood rounded so as to slip into the tube. The end will now present an oval. Cut out of sheet brass or copper an oval of the exact size of the end of the wood. Cut out its centre, leaving it as a flat oval ring $\frac{1}{16}$th of an inch wide; or a ring may be made of brass or copper wire. Push the wooden mould into the tube, so that its end comes within $\frac{1}{10}$th of an inch of the end of the tube. Drop the metal ring in the tube, so as to lie perfectly dead on the wood, and solder it in its place. This can be done easily with a blowpipe, or even with an ordinary soldering tool. It need not be soldered all around, but only in such a manner that it shall be firmly held in its place. The tube need not be more than $\frac{1}{2}$ in. longer than the angle. Cut a pattern of the oval in paper, and send it to an optician—say, Mr. Lancaster, of Birmingham—and get a score of micro films cut to the requisite size. Ten or fifteen of these are put to lie on the ledge, which the ring in the tube makes, and can be retained in position by a paper tube cut to the same angle. When all are ready, the inside of the tube must be made a dead black, and each film must be carefully cleaned. This may be done without breaking the glass, by rubbing them between the folds of a silk handkerchief, held between the finger and thumb. This is now to be attached to the eye-piece, and placed in the tube, when it will admit of being rotated. For the polariser, Fig. 8, make or procure a tube, A, to fit into the tube attached to the diaphragm of the microscope described, and $\frac{1}{2}$ in. long. To one end solder a disc, B, $\frac{1}{2}$ in. larger in diameter than the tube, and with a central hole the same size as the tube. To this solder another tube, C, slightly less in size than the disc, and $\frac{3}{4}$ in. long. Turn the whole up true in the lathe, and mill the edge of the disc for finish.

A piece of tube, D, to fit tightly into this must now be used for the polariser, and made precisely on the same plan as the analyser already described. When made, films of glass must be procured to fit it. Of course it will be understood that both parts may be made of the same size. If so the same plates of glass will do for both; and perhaps it would be cheaper to have, say, forty films of one size cut than twenty of two different sizes. The number of films used will be determined by trial. What is wanted is the maximum of colour with the maximum of light. As the depth of colour is dependent on the number of plates, and as the decrease of light is in the same ratio, judgment must determine in each individual case, after experiment, when the loss of one makes up for the other.

Having got so far, we will put our instrument together. Place the selenite plate on the stage, and throw up the light by the mirror, and, just for a simple experiment, we will dissolve a bit of sugar in hot water to saturation. Put a drop or two on a clean slide, warm the glass until the sugar begins to crystallise, and place it on the stage, and focus the microscope. We shall now have an object worth admiring. Nothing, I think, in nature is more marvellous than to witness crystals being built up—here slowly, and seemingly by much effort; and then suddenly, in another part of the field, to see a crystal flash across the field of view too quick for the eye to follow, and all glowing at the same time with the richest colours, ever varying as we rotate the analyser or polariser. Such an exhibition as that will, if I do not miscalculate on the enthusiasm of the young philosopher and scientist, fully repay him for all his past labours in optics. Having finished our instrument, we must prepare our objects, both plain and polarising.

It will be understood that this is a wide subject. As I intend to prepare a brief paper treating on the various classes of objects and the methods of mounting them, I shall do little else in this place beyond indicating a few interesting objects and modes of mounting. It must be understood that each of the three great kingdoms will supply us with illustrations.

But in this utilitarian age of ours it may be asked of what practical use is the polariscope beyond being a mere instrument affording pleasure. The answer is that it imparts information relative to the structure of bodies; and although no great commercial advantage can at present be derived from it, yet it must be remembered that no true knowledge is valueless. The history of all human progress is the result and sum total of accumulated facts. The same substance when viewed by polarised light will always present the same appearance, as truly as the same elements give the same lines in the spectroscope. Hence in the hand of the chemist it is the means of detecting adulteration. For example, any substance added to butter will reveal itself. Or the starch of potatoes may be detected in corn flour.

As a variety, we may make up some slides of mineral salts. One of the most beautiful is crystals of nitrate of silver. A little should be dissolved, and then a drop placed on a slide and allowed to crystallise. Sulphate of copper, sulphate of iron, chlorate of potash are but a few to practise with.

We will now turn our attention to a few vegetable preparations. These, though equally beautiful, are much less difficult to prepare.

Cut a thin section of oak bark longitudinally, and plane with the tree. Soak it in turps to render it transparent, and mount with Canada balsam. Here we shall see the cells filled with star-like crystals. Sections cut from rhubarb, also from the onion, will show crystals. The hair-like substances under the shell of the chestnut are good specimens, mounted in dammar. Different kinds of starch, flour, potato, etc., are beautiful and instructive. Of animal substances, prepare a thin section of a corn from the foot section of whalebone, various fish scales, and white hair—human. These must be soaked in turps and mounted on balsam, and are really beautiful objects.

It must not be supposed that the subject of polarisation has been exhausted in this article. I have, in fact, but touched the skirts of the subject. And, indeed, it requires ability far greater than mine to bring the whole of this subject into such a form that it could be readily grasped by the scientific tyro.

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LOCK REPAIRING AND KEY FITTING.

BY THOMAS WILSON.

LEVER LOCKS: THEIR CONSTRUCTION, ETC.

BEFORE giving a detailed description of lever locks, it will be as well to commence with a general description of them. As I said at the commencement of these articles, backspring and tumbler, or warded, locks are really no protection at all against force or fraud, and as from the nature of their construction they are capable of very few variations, it follows that there are hundreds of a similar pattern in existence. Indeed, I have known instances where one street door key has opened half the doors in the street. It is, no doubt, very convenient to be able to borrow your neighbour's key if you have lost your own, but the advantage hardly outweighs the disadvantage.

Ordinary lever locks, however, though not absolutely unpickable, are sufficiently so for general purposes; and those made by Messrs. Chubbs, Messrs. Hobbs, and other eminent makers, with patented improvements, may be said to be absolutely unpickable. That Messrs. Hobbs and Co. consider theirs unpickable may be judged from the fact that at the exhibitions of 1862, 1867, and 1873, they offered a reward of 300 guineas to any one, skilled mechanic or otherwise, who could pick their locks; and it speaks volumes for their security when we find that no one attempted to do so, though they were examined and inspected by some of the best mechanics in the world.

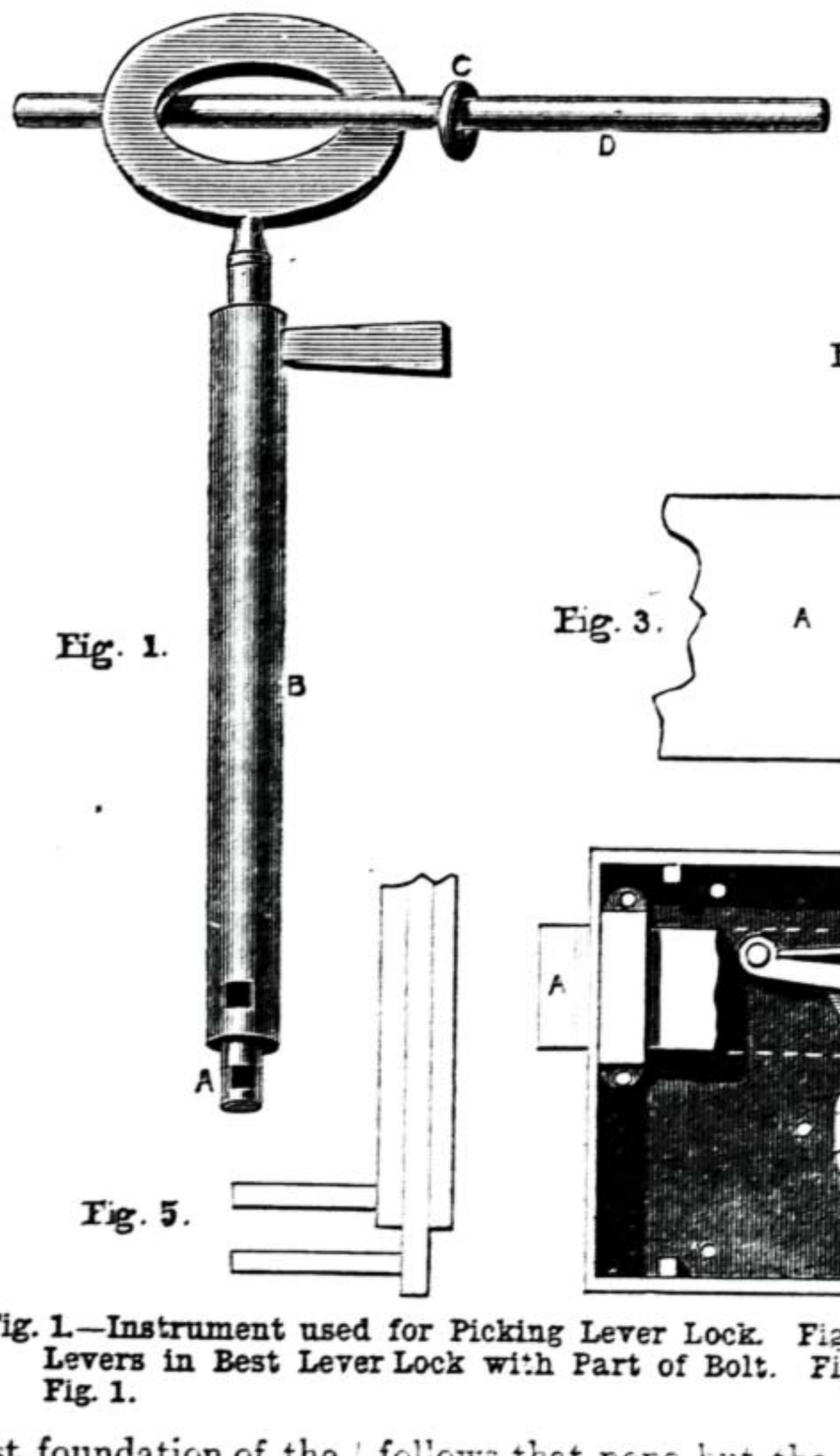


Fig. 1.

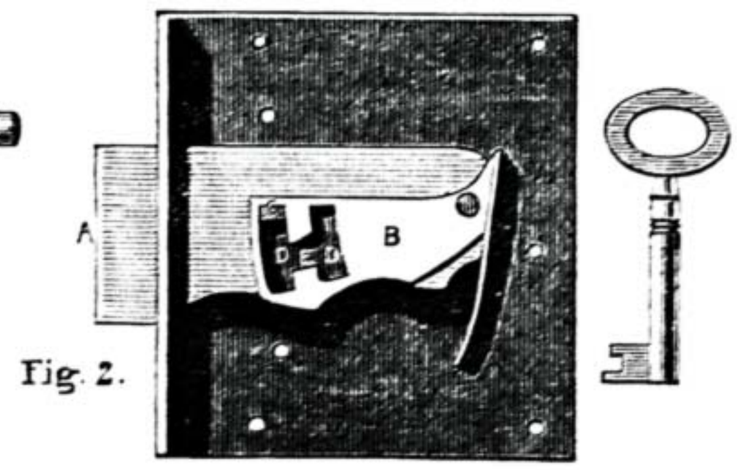


Fig. 2.

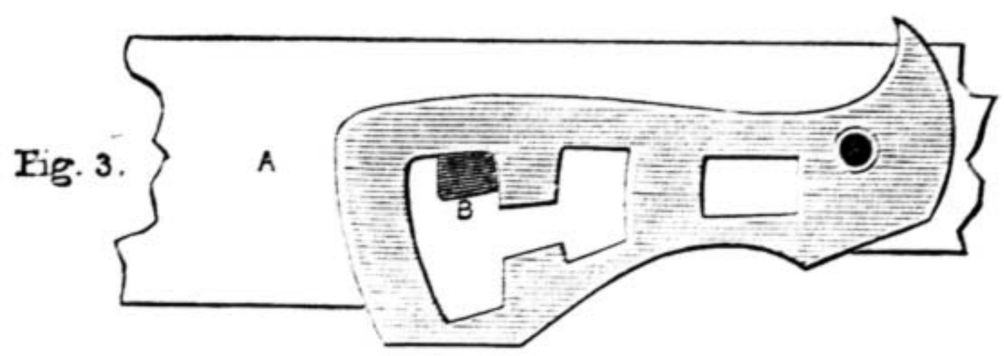
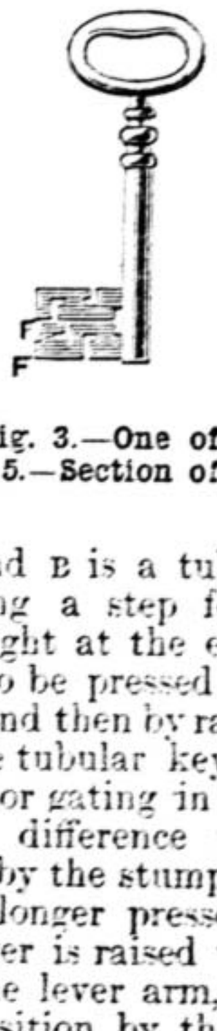


Fig. 3.

Fig. 4.



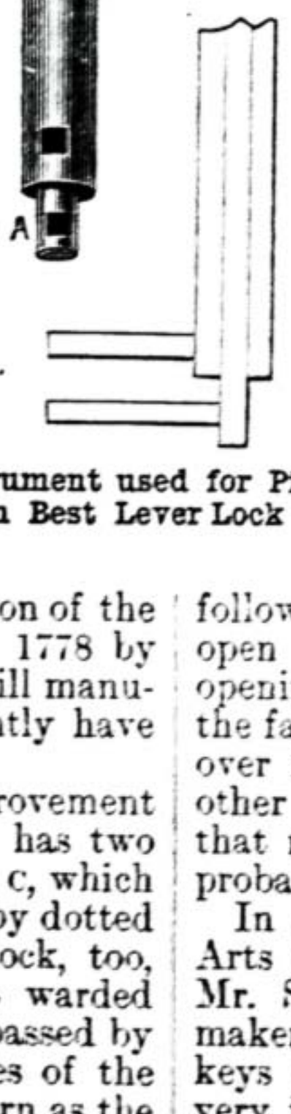


Fig. 5.

Fig. 1.—Instrument used for Picking Lever Lock. Fig. 2.—Ordinary Lever Lock. Fig. 3.—One of Levers in Best Lever Lock with Part of Bolt. Fig. 4.—The Barron Lock. Fig. 5.—Section of Fig. 1.

The Barron lock, Fig. 4, although it can hardly be called a lever lock, may be justly considered the first foundation of the modern lever. It was invented in 1778 by Robert Barron, and, I believe, is still manufactured; at any rate, I frequently have them to fit keys to and repair.

This invention was a great improvement on the ordinary tumbler lock, as it has two tumblers, B, B, with two studs, C, C, which work in slots in the bolts, shown by dotted lines, D, D. The wards in this lock, too, are more intricate than in most warded locks; but they can, of course, be passed by a skeleton key, and as the bellies of the tumblers are nearly the same pattern as the key, they can easily be lifted to the right height by a skilled locksmith. To fit a key to this lock first cut the wards in the blank as described in page 322 (although, of course, a much finer chisel and file must be used); then cut the steps, F, F, in the key, so as to raise the tumblers to the right height.

Fig. 2 shows the ordinary lever lock. All the best modern locks are made on this principle, with additional protecting contrivances. No wards are used for these locks, except for arranging suites of locks with master-keys; and the single tumbler is replaced by a number of levers. Fig. 3 shows one of these levers with part of bolt. The lock shown in Fig. 2 has only two of these levers, but this is a very ordinary kind. Of course each additional lever adds to its security, and some of the best makes have as many as fifteen.

On looking at the illustration Fig. 3, it will be seen that the bolt, A, has a stump, B, affixed to it at right angles, and that the lever has a passage cut in it of sufficient size to allow the stump to pass through. In the illustration the lever is shown in the position it stands in when the bolt is locked. In unlocking the lock each lever has to be raised so that the passage comes exactly opposite the stump, and as each lever has the passage cut at a different height it follows that none but the original key will open it. That they are secure against opening with false keys may be judged from the fact that a seven-lever lock is capable of over four thousand (4,000) changes; or, in other words, it would be necessary to try that number of keys before there was any probability of succeeding in opening it.

In a paper read before the Society of Arts (Lord Grimthorpe in the chair) by Mr. Samuel Chatwood, the eminent safe-maker, he stated the manner in which his keys were cut by machinery. As this is very interesting, I will take the liberty of quoting it in full:—"A very important requirement in safe locks is that no two should be made alike, in order that there should be no possibility that the key of one safe should open another. The method in use in my works, and also, I believe, in some others, renders it absolutely impossible for two locks to pass, unless specially made to do so. The key consists of a number of steps corresponding to the number of levers—say, for example, eight. These are of different lengths. They are cut out of the key blank by eight circular saws of different diameters, placed in a pack on a mandrel. The key blank is held in a special vice fixed on a slide rest, and is brought forward against the saws by the screw of the slide rest. The saws thus cut out the steps. Each of the saws is numbered, and for the first key they are placed in the order 1, 2, 3, 4, 5, 6, 7, 8; for the second in the order 1, 2, 3, 4, 5, 6, 8, 7, and so on. The number of changes—*i.e.*, the number of different keys—which can be cut with a set of eight saws is 40,320, which may be extended almost indefinitely. To make a second set of 40,320, it is only necessary to alter the diameter of one of the saws, or to vary the depth to which they are allowed to cut into the key blank. Keys are made in this manner for store. When the locks are finished, with the exception of the cutting of the gatings, the locksmith receives keys from the store, and marks off and cuts out the gatings to correspond with them. The lock is made to the key, therefore, and not the key to the lock. A very beautiful machine was introduced by Mr. Fenby for cutting his key bitts by the use of one saw; but I prefer the plan of having a number of saws equal to the number of levers, each saw of different diameter from any other, and carrying its own number, and transposing the saws for each set of keys."

Though for a long time considered unpickable, it has been found possible to pick lever locks. Fig. 1 shows one description of instrument used for this purpose. A is a solid key with one step, used for engaging with the bolt, and B is a tubular key fitting over A, having a step for raising the levers. The weight at the end of A causes the bolt stump to be pressed against the face of the levers, and then by raising each lever in turn with the tubular key, B, the position of the passage or gating in the lever is ascertained by the difference in the friction when pressed by the stump, and when in position and no longer pressed by the stump. As each lever is raised the weight C is carried along the lever arm, so as to keep them in their position by the extra pressure, and when all the levers are raised the bolt slides back. Should the lock have a pin, as it probably will, the pin must be knocked out and a hole drilled in the plate to support the key, or two very thin tubular keys may be used, when it will be unnecessary to remove the pin.

But picking a lever lock is a very tedious operation, and can only be accomplished by a skilled locksmith, so that for general purposes ordinary lever locks afford ample security.

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THE VERGE WATCH: HOW TO CLEAN IT.

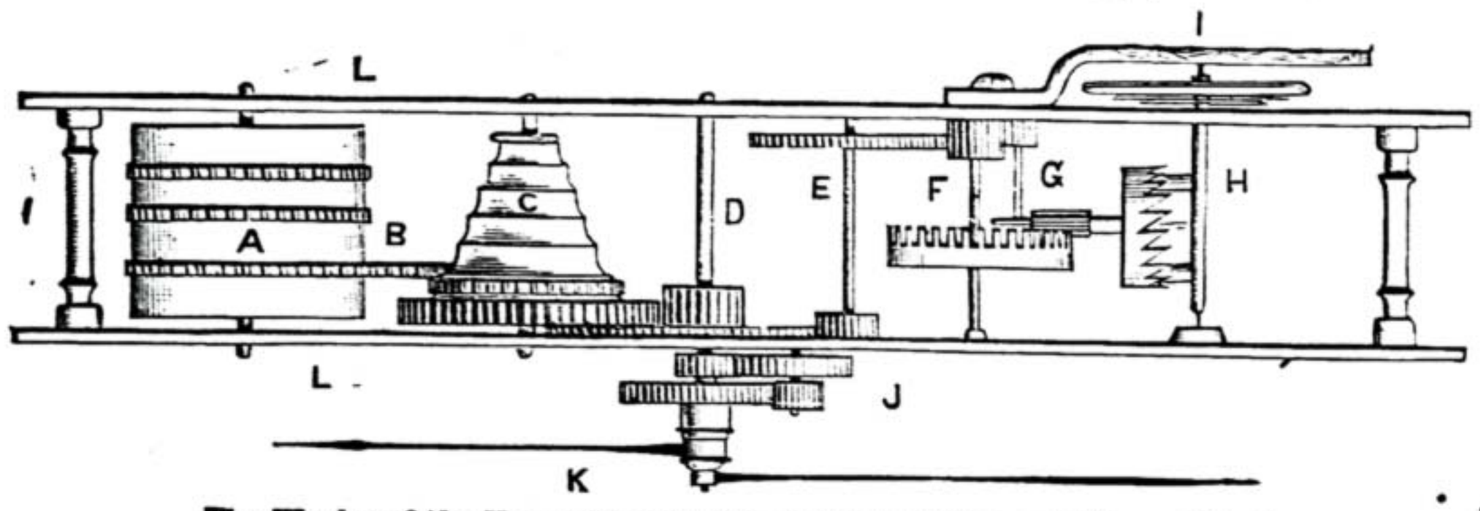
BY A PRACTICAL HAND.

THE old-fashioned or common verge, so dear to our ancestors, and even, in another way, to ourselves, is properly called the vertical, from the escape wheel being placed to turn in a vertical manner; this wheel is the one with saw-like teeth under the balance wheel; the wheel which turns the escape is the crown wheel, being in the shape of a coronet.

The amateur had best procure the following tools, etc.:—First, an eye-glass, costing 1s. 3d.; a pair of tweezers, 8d.; small tooth-brush, 6d.; small screwdriver, 3d. (a broken steel crochet hook, ground shape, makes a good substitute); a darning needle or large sewing needle driven into round piece of wood for handle, with the eye broken off and just touched up on stone for a push-pin; a piece of prepared chalk, 1d.; and 2d. worth of pure almond oil; this had best have two or three small slices of lead dropped in to allow the fatty matter to adhere to. In a day or two pour out the oil into a very small bottle for watches, and remainder will do for clocks. To the cork of the small bottle inside, fix a sewing needle with eye reaching into the oil; this is for oiling with.

Now place upon your table an oblong piece of clean white paper, say, 18 in. × 12 in., so that any small screw will easily be seen and not lost. Commence by taking the outer case from the verge, and open glass frame, notice, at 12 on dial, the hinge holding in the works; push this pin out with the push-pin (already mentioned) at the 10 o'clock side, thereby relieving the works from inner case. Now hold the watch movements in the left hand and study them well over—don't think it time lost—so as not to be at a loss how to put them together again. Now lift off the two hands at once, which is very easy in a verge. The blade of an old worn pen-knife is best to draw out the three dial pins, and be careful to hold it over your table in doing so. Lift off the two dial wheels, J, and then the steel one; it will be rather difficult; raise it gently all round with the knife point. The next is to let down the main spring. This is rather difficult for an amateur. First place a small bristle or piece of paper on the crown wheel teeth to lock it, and then unscrew the cock or cover of balance, holding the works very steady with left hand; lift off the cock with tweezers. You then expose the balance with hair spring attached; notice the square stud through which the end of spring passes and is so pinned in; make a small mark to where the end of spring comes, so that in replacing you can do so exactly in same position. This, of course, is only for amateurs; practical hands know how to place in beat at once, but amateurs cannot have it too clear. Now notice the way the pin is put in the square stud, and push it out with a screwdriver, and draw spring out with the tweezers and be careful not to break the balance staff by lifting it out of its hole; place what you have taken out carefully on your paper out of the way of your work; now fix your winding key upon its square, and then lift out the bristle or paper. Immediately the wheels will swiftly commence to run down, but take hold of the key in your right hand and gently hold on until it is run down; be sure to do this, as some amateurs have lifted off the top plate before letting down—consequence, a broken pivot or two. Holding the movement still in the left hand by the finger and thumb, push out the four pins, one at each pillar, and then lift very carefully the top plate off. Now notice how the wheels are; you will find the escape wheel attached to the top plate, but at present we have to do with the others; and with tweezers lift out the crown wheel, then next small wheel, and now just turn the barrel or main-spring wheel (which every one knows) a little, and lift out the chain hook out of the fusee hole; now take out the barrel, and a small ratchet wheel will drop from it at the underside; be careful not to lose it, and then lift out the fusee wheel, next the centre wheel, and now all is clear. Unscrew the small screw holding the wheel in position upon the upper plate, and release that wheel carefully; put it separate with its stud and screw so as not to mix the screws; you may easily ruin a hole by trying to fix a wrong screw into it. Now all is to pieces, because very few ever take out the spring from the barrel; if they do it does not run long after until it breaks, which of course is good for the trade; why they break I need not explain. But notice a mark upon the barrel, another on the lid; these must be put together when you put it back; prise out the lid, brush out the old oil and dirt in every part, then just place the least drop of oil on the coils of spring, replace lid, the two marks together as stated before; now run the brush a few times over the prepared chalk, and holding the box betwixt a small square of clean soft paper, brush it quite bright, and place it under a wine glass (one whose shank has gone is best); now take the chain which was upon the barrel, and draw it a few times betwixt a small piece of wash-leather, and then draw it a few times betwixt a piece of oil paper; place under the glass. Take the fusee wheel, clean and brush the teeth crossways, be sure to leave no dirt or chalk in any part, add it to those under the glass, and so with the other wheels. Next the plates, but in brushing them be sure to use the brush in a circular fashion, or the brush marks will show. Now comes the most careful part—the balance. To clean and not to injure the spring, take a small piece of writing paper, size of half a crown, put a small hole in the centre, then from it cut to outer edge; slip this under the balance, but upon the hair spring; now clean the steel rim until quite bright, turn it over and dab the soft brush amongst coils of the hair spring, next clean the staff with its two pallets; place under the glass. Now brush the cock or cover of balance, and then clean dial and dial wheels; after this take a piece of hard wood (a restaurant tooth-pick does very well), make a fine point at the end, and with it clean all the jewel and other holes, also the cock hole and hole for end of balance at bottom. Now be sure all is clean; examine carefully with your glass, for one single particle of chalk or grit between a tooth will stop the watch, and cause you much trouble afterwards. Now see the holes are not worn oval, and the face of the pallets are clear of grooves worn in them by age; some people, actually watch repairers, profess to be astonished why steel pallets wear sooner than brass teeth of the escape wheel. The thing is quite simple: the two pallets receive all tappings of the escape teeth upon them, over a dozen taps for their one, every revolution of escape wheel.

All being clean and in repair (repairs will be given in a future paper), now commence to put together. First take top plate and refix escape wheel into its place with the part that holds it there by the screw for that purpose; try if you have given it too much or too little end shake; it should spin easily around by the slightest touch, but not more perceptibly the other way; place one drop of oil on the watch glass; this will be sufficient to oil the whole movement. Amateurs always oil too much. Now from this large drop take the least particle and touch each pivot of the escape wheel; now take the lower plate in your left hand and lift the centre wheel into its place, the spring barrel; next the fusee wheel which works into the centre wheel, then next wheel, and now the crown wheel; put it into position, then carefully put on the top plate to fit the four pillars, and with your tweezers or the push-pin guide each pivot into its hole, and gently push down top plate. When all are near their respective holes this is not difficult, and do not damage or break a pivot by hurrying over the job; when all is right, and the wheels turn round, put in the pins to hold the top plate, using the two short pins for those pillars that will be covered by cock, etc. Now by pushing the fusee wheel all should run easily; if so it is all right so far. Now take the chain, and notice the two hooks; one is round and the other is flat; the last mentioned is for the main-spring barrel; be sure of this point. Now hook to barrel at the small hole and press it firmly in, then put on your key to the under square and turn gently until nearly all the chain is wound upon it; pass the other end hook under the pillar, and hook it into small hole with a centre bar in it; see you get it on to this bar, and the chain will lie in the first groove. Now tighten up the spring by putting on the ratchet and insert click; push the ratchet a little, passing the click in each notch with your thumb nail; give it a half-turn when tight, then wind up a little



The Works of the Verge Watch shown in Elevation on Enlarged Scale.

A, Barrel.
B, Chain.
C, Fusee.
D, Centre wheel, carrying minute hand.
E, Third wheel.
F, Crown wheel.
G, Escape wheel.
H, Balance wheel and pallets.
I, Cock or cover.
J, Dial wheels.
K, Hour and minute hands.
L L, Plates.

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with key on fusee and see it runs all right.

We now turn to the balance. First touch each end with the least oil possible, also the two pallets; place it into the square hole to receive it, and see you get the bottom pivot to its hole; be sure of this (I want to be certain about this, as amateurs are always in a hurry). Now pass in the end of hair spring to the mark you made, and pin it secure and spring level, then drop last coil into the regulator pins, and now place on the cock and move it gently until top pivot goes into the hole; try it by seeing if the balance will vibrate; now screw down tight, put pressure on fusee, and the balance should work if all is right. Now wind up, but guide the chain first time into the grooves, and you will now hear it ticking away as of yore. With the remaining drop of oil touch each hole and pivot top and bottom. Now place it under the glass, face side down, and try it for a few hours, then if in full vigour, take up with paper and push on tight the steel wheel to centre pinion, under face, and push down tight; and now the brass one with small hole in centre to the pin near by, so that it works into the teeth of the steel wheel, and now place the remaining wheel on to the centre steel one so that it works into the brass one before mentioned. Now place on the dial and hold it firmly; turn over and pin it on safely; clean the cases with rouge and leather, and place in the movement; push in the large pin thin end first at the two o'clock side, and close the cases; put in the glass, of course, first, and the hands. Listen if it has an even beat; if not, see last paper for defects and their remedies.

We will now proceed with the well-known horizontal watch, which sometimes was called the anchor escapement, as the points of escape wheel are the shape of an anchor's points. The invention of this made a great change in the wearing of watches, as the price brought them within the reach of all, coupled with their accurate time keeping. The inventor of this escapement was George Graham, who also invented the dead beat in clocks. I have more faith in this make of watch than in many so-called cheap watches; they are reliable with fair usage, and are very durable, surpassing the verge in many ways, neat in appearance, weigh little, and cost 15s. to 80s., in fine silver cases. They are the watches to buy by those who have slender purses; some have more massive cases, and imitate the English lever in appearance.

To clean it, open the outer cases, inner dome, then the glass dome over dial; now turn it over, and with your eye-glass on look for a half-headed screw near the balance, cock, or cover, turn it half round, then push out the movement from the cases entirely, face side; take hold of them in your left hand, and lift off the seconds hand, and then minute and hour hands; now turn over and draw out the two pins which hold the dial (some dials have two small half-headed screws to hold them on); now take off the three dial wheels as described in last paper. Turn it over and place a small bristle in the escape wheel; now unscrew the cock or cover, and carefully take it partly off with the tweezers; you will see that the hair spring is pinned into a square stud at your right; lift out all together with tweezers. You will notice that balance wheel goes under centre wheel. Now, when all is free and clear of escape wheel, turn it over and lay that side up under glass; be careful of the balance part, as the cylinder is very expensive to replace, and liable to be broken unless every care is taken in handling it; 5s. to 7s. is sometimes charged for a new cylinder, which is little less than robbery in my opinion.

To proceed, put your key on the centre square, and now lift out the bristle and hold the key so as to let it gently down until spring is spent, then unscrew the small screws which hold the top and bottom plates together (but first draw out the centre square with small pliers), and you will find the barrel wheel will remain attached to top plate; now take out centre wheel and the next two, and place them so that you will remember which is which; of course, if they get mixed, you can easily see the two or three dots on the underside, which shows you plainly; next unscrew the small cover over the escape wheel. This wheel is a very delicate piece of mechanism; handle it with great care. It is considered the most wonderful piece in a watch, to be so finely made and so perfectly accurate. Now the movement is all to pieces, providing it is a skeleton movement, that is, each wheel is fixed by a separate cover and one or two screws (this make is easier for the amateur). Proceed by unscrewing the centre wheel at each side, then spring box, and next the two remaining wheels; now brush the plates in a circular way; clean the holes with peg wood, and with glass see that no jewels are broken or holes worn oval; if so, see last paper. Now brush with prepared chalk the various wheels, and be very careful with the fine steel escape wheel; notice how far the hair spring is through the stud, and make a mark as previously mentioned in the verge details; clean it same way; brush the cock well and polish the regulator. When all is clean, dial and dial wheels, take bottom plate in the left hand, place in the spring barrel, then the centre wheel; next two, and drop on the top plate and guide each pivot to its place; push down, and try if they turn easily; if so, screw down the plate and put in the centre square, and push down tight; next place in small particle of oil to each jewel hole of escape and balance wheel at bottom, and replace the escape wheel with its cover screw down, but be sure and try it to see if it is in the holes all right. Now oil all pivot holes. It should commence to tick by using a little pressure on large wheel; if it does, all is right; wind it up and place under your glass cover to try it for a few hours; should the beat not be equal you have not carefully replaced the hair spring; you can easily see if it is not so by gently holding back the centre wheel until the balance is at rest. Now notice one small dot on rim of balance wheel, and three small dots on bottom plate just under it; if the dot on rim rests opposite the centre dot on plate, it is in correct beat, if on either side it is out of beat, and you will have to take off cock and lift it and balance out at once, carefully. Of course, be sure to put in bristle to prevent movement running down. Now turn over the cock with balance attached, and partly push out pin holding hair spring, and move the hair spring the least bit the way that will place the dot on rim with centre one as before stated; pin it secure and try it; if not quite right move it a little more. You could do it without taking out, but for an amateur it is the safest way, as you might slip in pushing pin home, then the hair spring would be ruined. If you have the two dots right, screw down cock and take out bristle, and tick will be correct. You might touch the escape wheel two or three teeth with the least oil; some do and some do not; I think it is better. You can now replace the centre steel wheel under dial, pressing it firmly down, not too much, and place on the other two as mentioned in the verge instructions; place on dial, turn over and fix two pins to dial feet, or screws if they are used, clean the cases with rouge, and take the movement and replace in cases. Notice at one side three small studs on plate next to dial, and see that centre one goes to a notch in case rim, and then push down the other side, and twelve o'clock will be at its place under watch neck, unless it is in hunting cases, when three o'clock will be in that position. Now turn over and turn the half head of screw on to rim of cases to secure it; next put on the seconds hand and hour hand, press down to position so as to clear the seconds, and also give room for minute hand to pass over; now lay down the watch and press on the minute hand; sometimes it requires the least tap with small hammer to fix it tight, having the under square resting on your bench rivetting block; put the minute hand on 60 and the seconds hand on 60 also, when, if dial is correctly marked, they will always coincide. Do not turn the hand so much; many are continually forgetting to wind up regularly, so have to be turning hands frequently; this spoils the watch in time, requiring to be tightened up, etc.

Now, when in the cases, you can hear more distinctly if any rubbing sort of noise is going on; if so, see repairs in the last paper. If all right it will only require regulating. If it loses, touch the regulator point the least particle towards F and try it again; if losing still, move it a little more until it goes perfectly correct, or *vice versâ*; use your eye-glass so as to do it correctly; it is worth while timing it by a good clock or regulator. London is famous for some excellent timekeepers—Greenwich time. You may manage to time up to the minute a month, which some speak of their watches doing; if so, it will satisfy you.

A SIMPLE METHOD OF DRYING AND KEEPING WOOD.

BY R. W.

In an article that appeared in one of the early numbers of Work, entitled "Friendly Hints to Amateur Wood Workers," the writer speaks of drying seasoned wood. It struck me that an arrangement I have for keeping wood ready for working might commend itself to some of the readers of Work, who are put to the inconvenience that I was before I thought of this method, and who have the requisite features in their homes. These are a passage on the ground floor about 20 ft. long and easy accessibility from without.

I will first describe my own, and then, for the benefit of any who may adopt this method, suggest what experience has told me would be improvements. I had long felt the want of a place to keep boards, etc., dry, so as to have them ready for working. One day the following idea occurred to me: namely, to keep the wood on stages in a passage. I selected one in the basement, which was most suitable, as appearances did not matter, having only the kitchen, etc., leading into it.

This passage is about 14 ft. long, 3 ft. wide, and 9 ft. high, with a door at one end leading into the garden. by which I get the

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wood in and out. In it I placed a couple of stages, with about 6 ft. 1 in. head-room; why I allowed so little will be explained later on. No. 1 stage I placed about 4 ft. from the door, and No. 2 about 7 ft. from this. The uprights were made of 2 in.×1½ in. batten, and the cross pieces for the wood to lie on were 2 in.×4 in. laid flat, which is quite strong enough for so short a span. These frames stand on a concrete floor that takes the weight, and are fixed by one or two nails into the walls, which are brick. If they had been lath and plaster, I should then have used screws, and this would be quite steady enough. I now placed the cross pieces and fixed them with small W. I. angle brackets, such as you can get at any ironmonger's; they are cheap, being only a penny or so each, and make a very strong job. I advise those who do not care to waste time on rough jobs, such as this, in making mortises, etc., to use brackets. I have a chicken house and run erected with them. Another advantage of using these is that they enable a job to be taken to pieces easily, quickly, and without damage to the different parts, being fixed with screws.

But to return to the staging: I have found by experience that a longer passage—say about 20 ft. or more if possible, so as to take floor boards, etc., without cutting—would be an advantage; also, if the stages had been closer together, say 5 ft. instead of 8 ft. between; and, in the case of a longer passage, more of them. The reason I allowed so little head-room was to keep the stage below the top of the doorway, allowing a space for the wood to be run in easily; but owing to its being so low, I found the top of the door when open fouled the ends of the boards. I therefore now have some pieces of wood, the required thickness, that I place under the boards when in position, to raise them up sufficiently to clear the door.

But this stage, I found, was not suited to keeping small pieces, such as ends 2 or 3 ft. long. So I decided to erect a second one; this I put in another passage against an end wall. I made the frames on the same principle as the others, but used stronger cross pieces, 3 in.×4½ in. batten, which I happened to have by me, as the span is 6 ft. instead of 3. This section is not too strong, if one wishes to keep a quantity of wood on it. One frame I placed 4 in. from the wall, and the other 3 ft. 6 in. from this, joining them with 2 in.×1 in. laths laid flat, and 1 in. apart, so as to keep all sorts of odd pieces without any fear of them falling through.

This arrangement has the advantage of occupying nothing but waste room, is always easy to get at, and also keeps the wood in very good working condition, with no tendency to warp or twist, because the hot air from the kitchen and different gas brackets in the passages circulates all round, and therefore dries it evenly.

The following illustrates its efficiency: In the autumn of last year I brought in some matchboarding, ⅜ in.×6½ in.×10 ft. long—in all 8 pieces. They were thoroughly soaked, having lain in the open for some weeks; in fact, they were dripping when first brought in. These I placed on the rack on edge close together, and in about a fortnight they were fit for working; nor had they warped the least, being as straight as when cut. One would be inclined to think the wood would get too dry if on the rack long, but I do not find it so, for some pine after being there eleven months cut as clean and as sweet as possible.

WROUGHT IRON AND STEEL GIRDER WORK.

BY FRANCIS CAMPIN, C.E.

Auxiliary Bracing, Floor Coverings, Permanent Set and Deflection.

In order to maintain the stability and properly corresponding positions of the different girders forming a complete structure, and secure them against disturbance from vibrations due to load and wind pressure, various kinds of bracings are used, which being accessory and forming no part of the structural design of the girders themselves, may be distinguished as auxiliary bracing.

This bracing will appear in the form of ties and struts passing from girder to girder in either a horizontal or vertical plane, the ties usually being placed diagonally and the struts at right angles to the lines of the girders to which they are attached.

In Figs. 15 and 15A two kinds of bracings are shown. A A and A′ A′ show in plan parts of two main girders lying parallel to each other, and connected by horizontal bracing between them to prevent lateral disturbance, and, therefore, sometimes called lateral bracing. This system consists of tie bars, B B′, B′ B″, C C′, and C′ C″, the pull upon which is resisted by the struts B C, B′ C′, B″ C″. These struts must be of some rigid section, angle, T, or H, to oppose the compression to which they are subjected. The ties, if not very long, may be flat or round bars, but if of great length a more rigid section is desirable to prevent their sagging with their own weight. Where cross girders occur they will themselves act as struts. In 15A, F F and G G show in vertical section two parallel main girders side by side, assumed to carry the flooring upon the top, and secured from overturning by vertical cross bracing, D D′ and E E′, lying horizontally, and D E′, D′ E, lying diagonally; these latter, as well as the former, must be of rigid section, as either of them may be put in compression or tension according to the direction of the disturbing force, which tends to distort the structure.

It is very evident that the utility of these bracing bars, other things being the same, will depend upon the correctness with which they fit into their places, hence the holes in one end only should be drilled in the shop, the holes in the other ends being marked off from the girders when they are put in position, and drilled at the place of permanent erection.

It very frequently happens that part of the section of the bracing bar has to be cut away at the end for a short distance to allow of the joint being properly made; in such cases the section of the bar should be made up by welding a layer on the end as shown at B, Fig. 16, which represents the thickened extremity of a T iron. It will be observed that as the vertical limb is cut away the horizontal table is thickened, and this is to be done to such an extent as to make the area across the rivet holes, after these are deducted, equal to the full area of the bar in its centre parts, so that it shall have equal tensile strength throughout. This thickening also enables us to secure proper bearing surface for the rivets or bolts. Suppose we have a T iron bar 6 in. wide on the table, and 3 in. deep vertically by ½ in. thick, then its sectional area, found by adding the vertical web to the table, will be 1¼ + 3 = 4¼ square inches; the table alone has 3 in. sectional area, so where the web is cut away its thickness must be increased to ¾ in. This is making it a little full (4½ square inches sectional area), but is practically near enough. The bearing of a ¾-in. rivet will be (thickness of bar multiplied by diameter of rivet) $\frac{9}{16}$ square inch, hence eight rivets will equal strength of bar.

When round bracing bars are used, they can be tightened up by coupling boxes such as that shown at H; the ends of the box are drilled, and screw threads cut in them in opposite directions—one right and the other left-handed — to fit which corresponding threads are cut on the inner ends of the tie bars, G and G′; thus by turning the coupling box while the tie bars are prevented from turning, their ends are placed nearer together or farther apart according to the direction in which the box is turned. In order to keep the full strength of the bars, the screwed end, D, must be made larger than the run of bar C, so that the diameter of the screwed part at the bottom of the thread shall not be less than that of the body of the bar. These ends are usually made from larger bars and welded on to the tie rods. Round ties are usually connected up with bolts passing through eyes in the ends, and these eyes must be made equal in strength to the bodies of the bars. The proper shape for an eye is shown at E, F; the distance from the edge of the bolt hole to the end of the eye should be one and a half times the diameter of the bolt, the bolt being properly dimensioned to suit the bar as follows:—The end of the tie bar being held between jaws or clips, the bolt will be in double shear, and, therefore, its sectional area multiplied by four tons per inch—the working shearing resistance—must equal half the sectional area of the tie bar multiplied by five tons; the working tensile resistance, that is, the sectional area of the bolt, must be ⅝ths of that of the tie, but the sectional areas vary as the diameters squared, therefore the diameter of the bolt must equal that of the tie multiplied by four and divided by five.

A good water-tight bridge floor has always been a desideratum, but the difficulties of erection militate against its acquisition, and as might be expected many different forms have been patented and put upon the market. For many years Mallet's buckled plates have been very largely used for flooring, and possess many considerable advantages over the earlier forms, inasmuch as they have great strength and are self-contained. Plain cambered plates require ties, and corrugated plates have no lateral rigidity to speak of.

In Fig. 17, A A is a section, and B B, a plan of a Mallet's buckled plate. It will be seen that it is dished, having a flat fillet left round the edge which forms a tension ring to the flat dome into which the plate is shaped. At M is shown a top flange of a girder carrying a flooring of these buckled plates riveted on to it. This rivetting must necessarily be done by hand, and under the disadvantage that the man "holding up" the rivet is unable to see his mate, who is on the other side of the plate.

At C is shown in section a trough-shaped flooring; the troughs are placed side by side and connected at the top by the joint plate D. These troughs act as cross girders as well as forming a covering, but being of limited depth necessarily involve the use of a greater quantity of metal for a given strength than is required when built-up girders are employed; the sides, too, which form the webs are much thicker than is necessary for strength if they are acting merely as webs. Another form of trough floor designed to remedy this last fault to

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some extent is shown at E E and F F. In this construction the bottoms of the troughs are rolled much thicker than the sides, and the bulk of the metal thus placed in a more advantageous position than in the previous form, but the same rivetting difficulties are present in both as occur with the buckled plate floors.

The latest form of floor plate patented is shown in section at G G. It consists essentially of a buckled plate, with the fillets, H, vertical, thus affording facilities for rivetting with a portable hydraulic riveter, and also saving half at least of the number of rivets required with the common buckled plates. I I is a plate girder; to the web of which floor plates are riveted as shown. This construction admits of making very close work with a minimum of labour.

When continuous plate floors are used, lateral bracing is not required, its functions being filled by the floor itself.

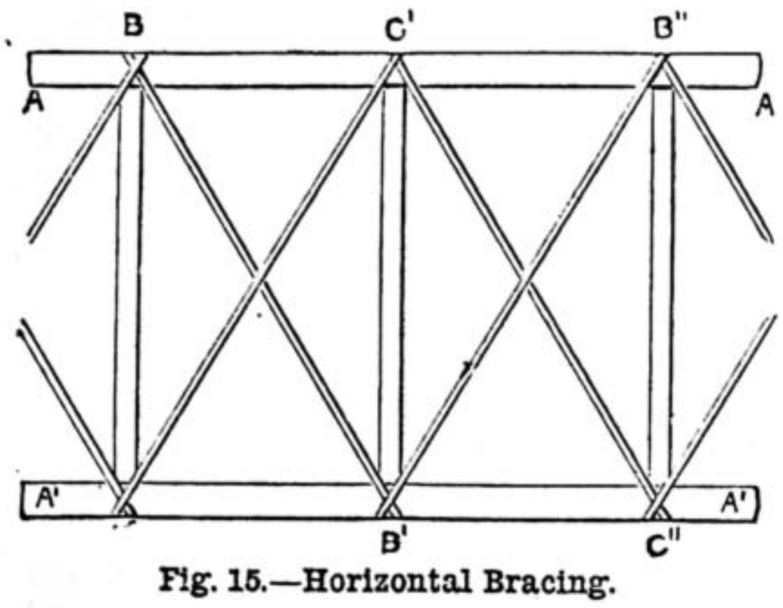

Fig. 15.—Horizontal Bracing.

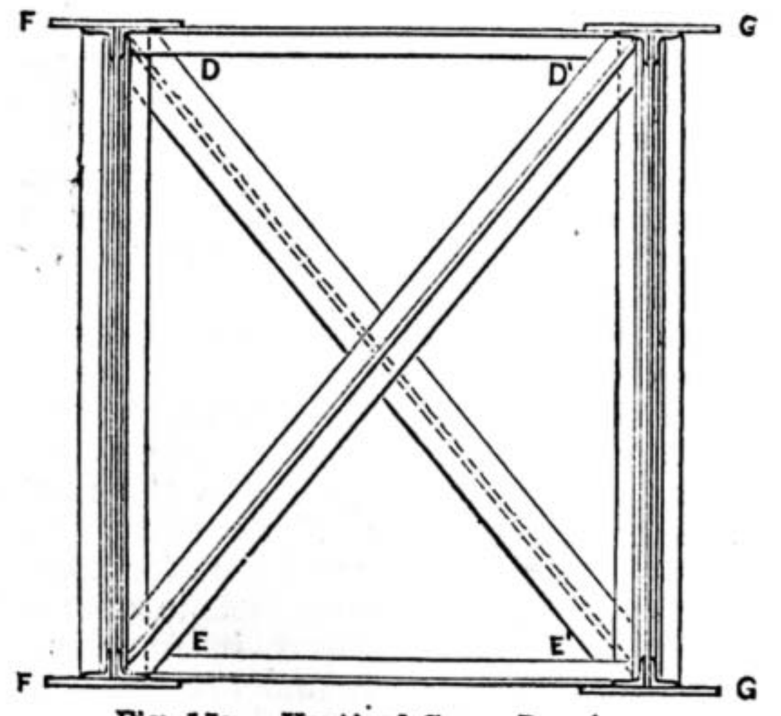

Fig. 15a.—Vertical Cross Bracing.

It is always advisable when girders are completed to test them, if not too large, previous to permanent erection, for although samples have been examined during the progress of construction, yet in the completed work some unexpected flaw may occur, or at some point the workmanship may be defective. It is from the deflection of the girder that its fitness for the purpose for which it has been designed will be judged. The deflection is divided into two classes, the permanent set under a test load, and the deflection which disappears on the removal of the load. In testing the solid metal itself before it is made up into girders, it may be found that on the first application of the load, a slight permanent elongation may take place without deteriorating the ultimate strength of the metal; this may arise from some want of uniformity of texture brought about by the exigencies of manipulation, and on repeating the test stress no further permanent elongation should occur, otherwise the material will ultimately break down under a stress much below its first breaking strength. At different times experiments have been tried to determine the effects of continuously repeating the imposition of stresses, and from them it may be generally concluded that so long as the applied load does not exceed one-fourth of the breaking load, it may be reapplied without danger for an indefinite number of times.

When a structure has been erected and all supporting scaffolding removed, a constant deflection due to its permanent load will occur and remain; on the application of running load, there will be some permanent set due to the joints settling to their bearings: beyond these there should only occur the temporary deflection due to passing loads. If the elasticity of the metal is known, the deflection can be calculated for any given girder. The value of the elasticity is the weight that will extend it a given proportion of its length, and the amount usually given is that load which, were it possible, would extend a bar one inch square to twice its length; this load is called the measure or modulus of elasticity. Although the supposed effect is not practically possible with iron or steel, this sum is convenient for calculation, as the extension and compression within the limits of elasticity vary directly as the stresses. The girder being assumed to have flanges of

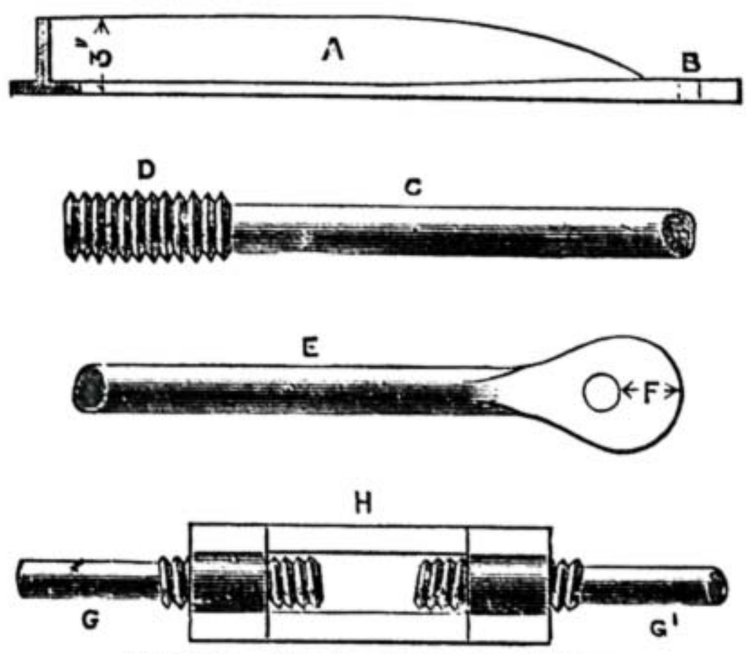

Fig. 16.—Ends of Bracing Bars.

equal length when unloaded, then on the application of a load the top flange will be shortened by compression, and the bottom flange lengthened by extension, and if the metal is so distributed that it is under the same stress throughout the length of the flange, for each square inch of cross sectional area, the central deflection will be found from the following rule:—The deflection of the girder at the centre will be equal to the span of the girder multiplied by the difference in length of flanges, and divided by eight times the depth of the girder.

The difference of length of flanges will be equal to the sum of the extension of the bottom flange and the compression of the top flange, and these lengths will be respectively equal to the strains per square inch of cross section on them, multiplied by the span and divided by the modulus of elasticity of the material. For example, let it be required to find the deflection at the centre of a girder 120 ft. span 11 ft. deep, having under a maximum load four tons per square inch compressive stress on the top flange, and five tons per square inch tension on bottom flange. The modulus of elasticity for good plate girder work is 8,000 tons; the extension of bottom flange will be 120 multiplied by 5 = 600, and this, divided by 8,000, gives $\frac{3}{40}$ ft. or $\frac{9}{10}$ in. The compression of the top flange will be 120 multiplied by 4 = 480, which divided by 8,000 gives $\frac{3}{50}$ ft., or $\frac{18}{25}$ in. These added together make the difference of the lengths of the flanges $1\frac{3}{5}$ in. (nearly). Applying the rule given above we have 120 ft. span multiplied $1\frac{3}{5}$ in. = 192, which divided by 8 times 11 ft. depth, gives $2\frac{2}{11}$ in. for the central deflection of the girder. It will usually be found that the actual deflection will be less than that calculated, because there is an unavoidable excess of metal in the flanges; should the contrary occur, therefore, it indicates the probability of a defect somewhere.

In measuring the deflection of a bridge its amount must be determined by deducting the depression at the bearings from that at the centre of the girders, for there will be some depression at the points of support during the passage of a heavy load.

The final stage of the work consists in painting or otherwise protecting it from external influences, and the choice of material

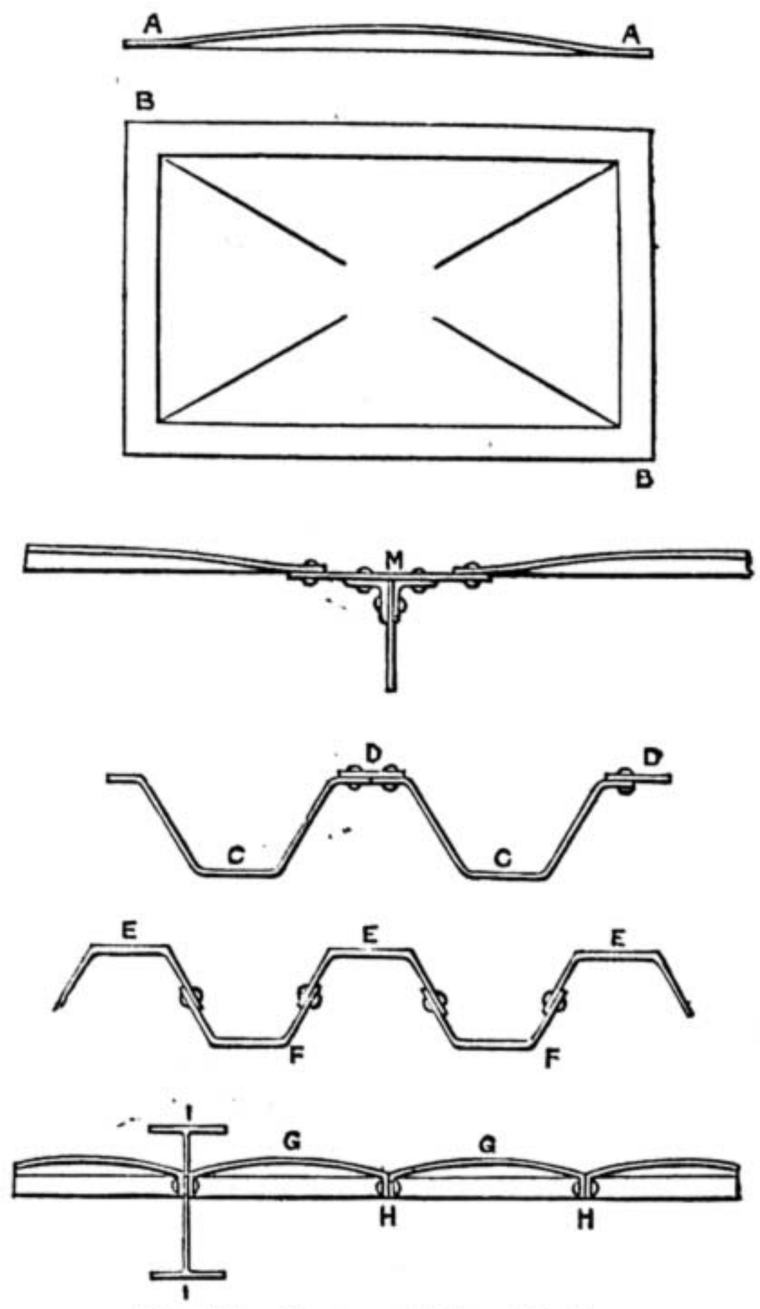

Fig. 17.—Forms of Floor Plates.

for this purpose is of considerable importance, for upon it the durability of the work is in some measure dependent. Paints made of iron minium have been much in favour, and the magnetic iron paints also have advocates; in all iron paints for iron work or steel work there is supposed to be the advantage over other metallic paints that dissimilarity of metals is avoided, and with it the risk of galvanic action being set up. A coating of iron rust, however, will not in itself protect the sub-lying metal from oxidation, but will even aid it to some extent, the corrosion eating into the body of the metal.

Looking at the matter from a purely practical standpoint, it would seem that the quality of the oil, or other vehicle carrying the colouring material, must be the criterion of its utility, as it is that which is in immediate contact with the work; it is, therefore, highly necessary to select a compound free from acid elements, and it must also be capable of resisting the acids and sulphurous compounds existing in the atmosphere.

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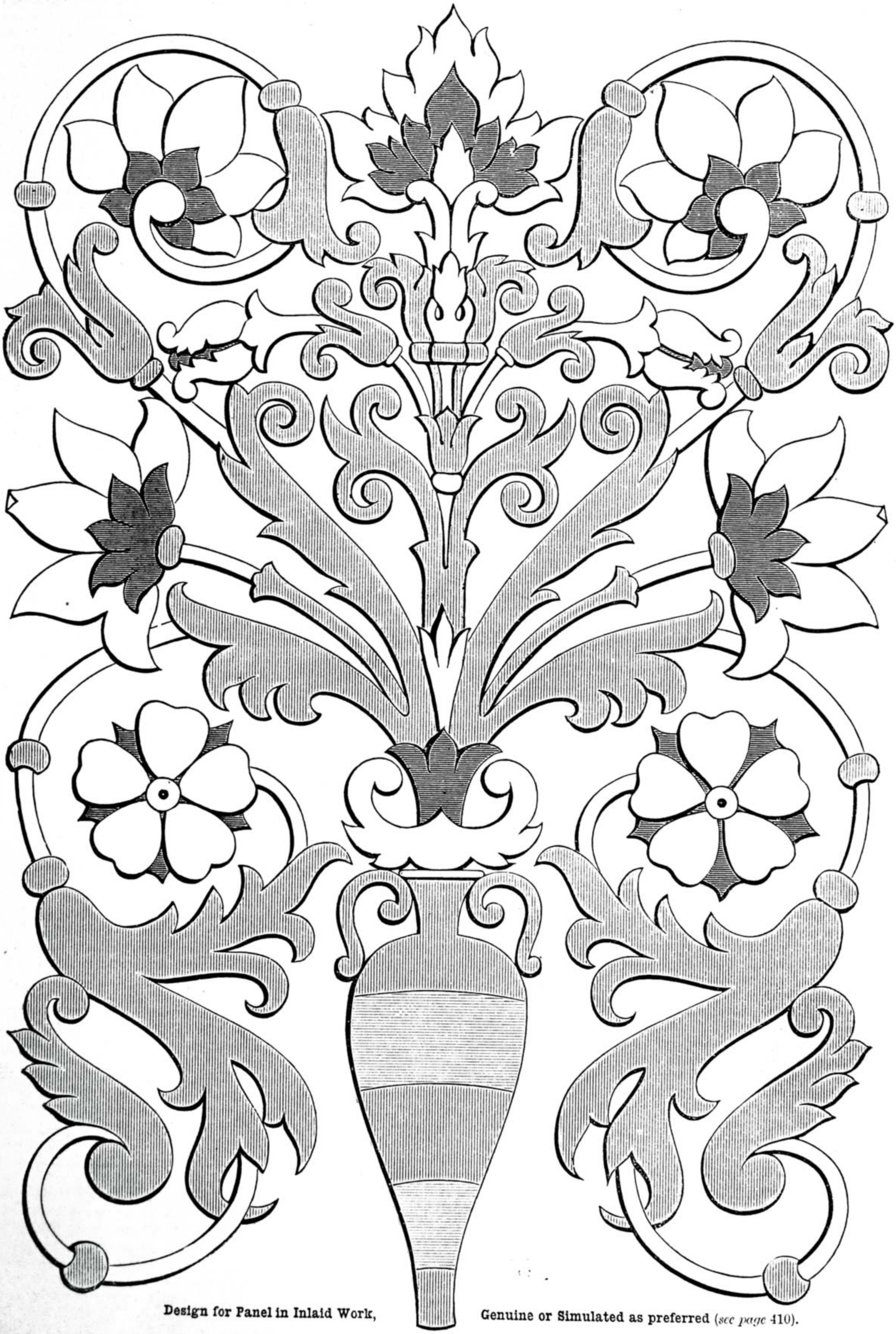

Design for Panel in Inlaid Work, **Genuine or Simulated as preferred** (*see page* 410).

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A PANEL FOR INLAYING.

BY E. BONNEY STEYNE.

REAL inlaid work—Marquetry, Buhl, Pietra-dura—all the varieties of the same idea, have been favourite modes of decoration in many countries and periods. And when employed with some reserve, used only to ornament the surfaces to which it is applied, and not to overload and conceal the natural wood thus treated. Inlay is a legitimate and effective wood decoration.

The genuine inlaid work presupposes a careful hollowing out of the solid wood for each separate detail of the design, and filling each space with its proper block of the chosen material carefully cut to fit the space. But this demands such absolute precision, and to some extent waste of labour, that the Buhl, or Boule, work, where veneers take the place of solid woods, and the fretsaw replaces the chisel, has been more largely used since it was introduced in France about 1680. But to fix a date for such work is misleading, as in Oriental work of fabulous antiquity the process is found to have been known in methods not unlike those now in use.

But modern substitutes have not stopped at imitating solid inlay by sawn veneers, and a variety of ingenious processes—one that by hydraulic pressure forces the material through the openings of a metal plate into the panel, some where printing simulates the real work, with many other modifications of these two—have replaced the real work with little loss of effect, however the lasting quality of the material so treated may have suffered.

To these there is a yet more simple substitute. It is to take a sheet of light wood, one with some natural grain, but not very distinctly marked pattern. Upon this, by means of the oily black carbonic paper, trace rather heavily, with an agate style, the design chosen. Then with a paint-brush fill up the pattern with various coloured wood stains and Judson's dyes, filling in the whole of the groundwork with dark brown or ebony stain. For a rough and ready decorative process that is almost mechanical, since not a single line of the design is drawn, but every detail traced from an existing pattern, this when well varnished or polished produces a fairly pleasant result.

The morality of all imitations is doubtful, but since they exist, it is better that they should be done as well as may be, and if the design to-day given has no peculiar charm, it is at least a possible one for practical work, and serves the purpose of a decorative centre for a larger panel fairly well. The parts left white are to be left untouched in the natural wood, the portions with plain shading to be in a darker tint, and those with crossed shading in a yet deeper colour. But the colours employed depend so entirely on their future surroundings that it would be folly to suggest them here.

HOW TO MAKE PHOTOGRAPHS ON BOXWOOD.

BY WALTER E. WOODBURY.

IT is many years ago since the first attempts were made to utilise photography as a means of producing pictures upon the boxwood blocks to be a guide to the wood cutter, but the results were found unsatisfactory. The reason of this was because, in the necessary manipulation the block was either spoilt by immersing in various solutions, or had to be coated over with a film of gelatine or albumen, which interfered with the work of the engraver.

The manner in which these blocks are produced at the present time is this. The drawing is first made by the artist direct on the wood in the same manner as if he were drawing upon an ordinary piece of paper, without regard to the effect of his block when printed from. This is the work of the engraver whose duty it is, as a rule, to break up the drawing into lines, dots, or stipple work, in order that the half tones or shadings will be truly represented, which they otherwise would not be.

So it will be seen that all that is necessary for the wood engraver is a picture of the desired subject as a guide for him to work upon, but it must in no way interfere with the surface of the wood or destroy its symmetry.

Those who are in possession of a camera and require to make printing blocks of landscapes, machinery, portraits, etc., for book or journal illustration, will find the following a far more simple and accurate method than employing an artist, besides being more economical.

We will presume you have the negative made of the subject you wish to transfer to the printing block.

First obtain a planished copper or zinc plate and scour it over with a piece of No. 2 emery cloth until it presents a rough appearance. Place it on a levelling stand on the hob of the kitchen fire, when there is a quiet fire burning. Get the plate quite level by the aid of the screws at the feet of the tripod stand and a spirit level. Then leave it to get warm, and prepare a solution of gelatine, 1 drachm dissolved in one ounce of water. Coignet's "gold label" gelatine will be found the best for this purpose. Dissolve, stir rapidly, and throw in gradually 5 grains of bichromate of ammonia. This quantity is sufficient for a half plate $6\frac{1}{2} \times 4\frac{1}{4}$; for larger sizes a proportionately larger quantity of course.

Now hold a thermometer two inches over the zinc plate, and when it registers 100° pour on the gelatine bichromate solution. If the zinc plate is properly levelled it will not run over, but can easily be spread evenly over the plate by means of a glass rod or strip of paper.

If the solution is found to contain any impurities it should be carefully strained through several thicknesses of muslin.

The zinc plate must not be too hot or all kinds of troubles will arise. When the coating is complete remove to a darkened room and allow to set and dry.

When dry it is ready for placing under the negative, but it must be remembered that it is sensitive to light.

If your negative is an ordinary glass one it will be necessary to make from it a reversed negative, otherwise your block when printed from will give reversed images, that is to say, objects to the right will be to the left, and *vice versâ*. In some cases this is of little moment, but generally it is necessary to make a reversed negative, unless the original is a film or paper negative, which can be printed from either side. These are invariably the best for this purpose.

The plate with the bichromatised gelatine film is then laid under a negative and exposed to light. The time required is a little less than would be necessary to produce an ordinary silver print. The exposure can be accurately gauged by the means of a photometer.

When the plate has been exposed to the light beneath the negative for the required length of time it is removed and placed in a bath containing clean cold water, and allowed to remain therein about ten minutes in order to wash out the bichromate which has not been affected by the action of the light.

Remove the plate from the water, and with a piece of soft muslin remove all the superfluous water by dabbing carefully over the surface of the gelatine. It will be noticed that portions of the gelatine film will be raised and others sunken to form the image. It has now to be inked.

Make an ink dabber by tying a few pieces of soft rags in a piece of soft muslin. A little letter-press or lithographic ink is taken on to a slab of glass, slate or metal, and with the rag dabber spread evenly over the slab. A very little ink is required, but it is necessary that it be kept evenly distributed.

The operation of inking is one that requires a little care and attention, though skill is not absolutely necessary. By taking up a small quantity of ink and dabbing on to the gelatine surface it will be seen that to some parts the ink will adhere; these are the exposed portions, while the unexposed parts will reject the fatty ink. The image will become visible, and it will be found that the inking can be well controlled by the pressure brought to bear upon the dabber; a heavy pressure deposits much ink, while a light one a smaller quantity.

When the plate is evenly and thoroughly inked the next operation is transferring the ink drawing from the gelatine to the wood block. For this we require a piece of bank post paper, or, better still, a sheet of Rives' or Saxe's paper. Place the sheet of paper between moistened blotting-paper in order to dampen. When sufficiently dampened it is laid on to the inky picture and contact established by means of a small wooden roller covered over with indiarubber tubing. Several sheets of blotting-paper are placed over the paper lying on the gelatine image, and with the rubber roller referred to carefully rolled until the paper adheres firmly to the gelatine film. With a moist sponge go over the back of the paper, and by taking hold of one corner and gently pulling the transfer paper will leave the gelatine, and will be found to have carried with it the fatty image. This transfer is now laid on the wood block, a few sheets of paper laid over it, and with the indiarubber roller well rolled into contact, and afterwards gone over with a piece of hard wood or the handle of a tooth-brush.

When the contact of the whole with the wood is thoroughly assured, strip off the paper by lifting from one corner, and the ink photograph will be found to have adhered to the wooden block.

This block is then ready for the wood engraver. In a future article I hope to give you a method of producing printing blocks by photography without the aid of either artist or engraver.

MEANS, MODES, AND METHODS.

A NOURISHING FOOD.

IT may not be generally known that the young leaves of the lime tree are excellent for food eaten as they are gathered, as salad, or boiled. Those leaves suitable are at the ends of branches or sprouting from the trunk of the tree, and have an amber tint.

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They are slightly sweet and mucilaginous, and easily digested—more so than most raw greenery used in salad. I have, when out surveying, used lime leaves often as food till I had a chance of getting a meal; and my family have partaken of this refreshing diet as a food when obtainable in the spring of the year.

Remedy for Severe Cuts.

First stop the flow of blood as much as possible by a ligature above the wound. If the cut be clean—that is, free from dirt or rag fibre—and the edges clean and level, use a needle and thread to draw the edges together, or stick pins—common ones will do—lengthways with the wound into the edges of the flesh, and with any thread or string draw the edges close by passing the string from pin to pin fairly tight. Now lay over the wound a piece of cotton wool, and pour on to the wool French polish till it is saturated; be sure to get the French polish well into the wool before the blood saturates it; now cover the wound with cloths, not too tightly put on. Keep the wounded limb or body resting as quietly as possible. If a ragged wound, as from a circular saw, apply a ligature above the wound, adjust the shreds of flesh as well as can be done, put on the cotton wool and pour on the French polish, then cover up from the air. If a finger be sawn off, do not throw the bit away, but see that the parts are clean, and put it back in its place, and bandage up in splints—any bits of stiff card or thin wood, about ¼ in. wide, will do, using enough to go all round the finger. It will grow, and be a stiff jointed one, but still useful, and more free from pain than a stump, and more quickly healed.

Treatment of Bruises.

If there is no fracture requiring surgical aid, pour on turpentine and rub in lightly; do not let the turpentine flow over the skin far and saturate the rag you cover the bruise with, as it may blister the skin beyond the bruise. Some bruises, as from the kick of a horse, are often best treated by the use of leeches round the edges of the bruise; wash the place with milk first; it makes the leeches bite; cover the place with a piece of washleather spread over with sweet butter or lard.

In such accidents the whole nervous system receives a shock. This should be allayed in the injured person by cheerful words of comfort, and the avoidance of exciting drinks or food. The following facts will attest the power of the nerves in influencing recovery from injuries. A lad was ascending a well eighty feet deep by the bucket, and was shouting in glee at the well-digging job being successfully completed, when just at the top the chain broke, and let the bucket and the youth fall to the bottom of the well. A new chain was obtained quickly, and a man lowered with a candle to bring up the dead body of the youth, as it was concluded he was killed; but to the surprise of the spectators he was alive, but with both legs broken off above the ankles, the bones protruding through the skin. The doctor saw it was a curable case if the nerves were strong, which seemed doubtful in so delicate a youth. So to cheer him he said, "Why, you have made a bad beginning at flying." The youth smiled wanly, and replied, "I did the flying right enough, but the settling was bad." The legs were set and soon healed, and he grew up a stalwart man and leader of men. In another case, in the backwoods of Canada, a lumberman was tree-felling, and his axe slid from the cleft of the tree he was felling and gashed through his stout leather legging down the shin of the leg. The man fainted at seeing a gaping, red wound. On recovering, he covered his leg up with a wrapper, and dragged himself to his sledge and hitched his horse to it, and galloped home. There he fainted again, and was put to bed. His wife, on his recovery, asked what was the matter. "My leg," he replied; "I have cut it through from knee to ankle." "It's all fancy," said his wife; "your legging was ripped open, but your new red stocking was not even cut." "I forgot I had put on those stockings to-day, and that is what I must have thought was blood," he answered. Even when sure he was not hurt his nerves were deranged for some time by the fancied injury.

OUR GUIDE TO GOOD THINGS.

*** *Patentees, manufacturers, and dealers generally are requested to send prospectuses, bills, etc., of their specialities in tools, machinery, and workshop appliances to the Editor of* WORK *for notice in "Our Guide to Good Things." It is desirable that specimens should be sent for examination and testing in all cases when this can be done without inconvenience. Specimens thus received will be returned at the earliest opportunity. It must be understood that everything which is noticed, is noticed on its merits only, and that, as it is in the power of any one who has a useful article for sale to obtain mention of it in this department of* WORK *without charge, the notices given partake in no way of the nature of advertisements.*

84.—Kendall and Cockcroft's Patent Screw Holdfast and Cramp.

I take the earliest opportunity at my command of advising my readers that the "Patent Screw Holdfast and Cramp," noticed and described in "Our Guide to Good Things," in No. 19 (page 299) of Work, bearing date, July 27, 1889, as "Lister's Patent Screw Holdfast and Cramp," should have been attributed to Messrs. Kendall and Cockcroft, Cabinet Works, Lane Head, Horsforth, the inventors, patentees, and sole makers of the appliance in question, to whom all orders should be addressed.

85.—The "Rigid" Folding Curtain Frame.

This Curtain Frame is a patent of Messrs. Gibson and Glazier, 97, Tulketh Street, Southport, the patentees of the Locking Stay of the "Firm and Safe" Step Ladders, recently noticed in these pages. The size of the frame is 4 yds. by 2 yds., the longer sides folding on a hinge placed in the centre and rendered rigid when opened out by a clip which slides over the joint when the frame is in use. The shorter sides or crossbars also slide in clips, which also can be moved along the longer sides, and which are also instrumental in keeping the four sides at right angles to each other, so that the frame is always square at the corners. Holes at regular intervals are pierced in all the sides so that the frame may be reduced in length and breadth at pleasure, so as to take small curtains as well as large. When the sides of the frame have been adjusted to the size of the curtain that is to be cleaned, they are held firmly by a thumb screw at each corner, which is inserted in the holes made for its reception in the sides, passing through both of the contiguous sides at each corner, and is then screwed up tight. There are points at short intervals along the upper surface of each side, on which the curtains are stretched.

These points are brass nails inserted along the inner and narrower surface of each side, at intervals of about one inch, and appearing in a deep groove cut in the upper surface to admit of this. It will be understood that they are in a direction parallel to the upper and under surfaces of the sides.

This Curtain Frame is confidently recommended for home use as the strongest, neatest, and best of its kind yet introduced. As a reason for its general adoption by families who wash at home, it is urged that curtains cleaned at home last much longer than those sent out to be cleaned. The price of the frame is 10s. 6d.

The Editor

SHOP:

A Corner for Those who Want to Talk It.

*** Notice to Correspondents.—*In answering any of the "Questions submitted to Correspondents," or in referring to anything that has appeared in "Shop," writers are requested to refer to the number and page of number of* WORK *in which the subject under consideration appeared, and to give the heading of the paragraph to which reference is made, and the initials and place of residence, or the nom-de-plume, of the writer by whom the question has been asked or to whom a reply has been already given. Answers cannot be given to questions which do not bear on subjects that fairly come within the scope of the Magazine.*

I.—Letters from Correspondents.

A Correction.—S. K. R. (*New York*) writes:—"In No. 20 of your valuable Magazine, I see a notice of an 'Automatic Measurer,' of which I am the inventor and patentee. Your description and illustration are alike admirable; but may I ask a small portion of your space to correct a slight error in the title. It is printed 'Rolymeter.' It should be 'Polymeter,' a word of my own manufacture, and signifying 'many-measurer,' an 'universal measurer.' May I also point out that, besides the uses for it you have mentioned, it will measure *curved* surfaces with equal facility and accuracy, such as the inside or outside circumference of a glass shade, for example. Before closing, I must express to you my delight in Work. I have had it from the commencement, and am always in a hurry for Wednesday to come. My plan is to get a copy every week to read and carry around with me, and every month I buy the monthly parts bound up (6d.), which I put away till the first volume is complete, when I shall have them bound up. Any number having fretwork patterns in it (I am great on fretwork) I buy several copies of. I should like to personally thank Mr. Gleeson-White. His papers are invaluable to me, and could he see into my rooms, he would recognise more than one of his designs. May his shadow never grow less! I have a nine-light fretwork chandelier of my own design, which I should be pleased to describe at some future time should you consider it worthy of a place in your columns. I wish you a circulation of a million a week."

An Easily-Made Fret Machine.—Anxious (*Barnoldswick*) writes:—"No. 21, page 332, 'An Easily-Made Fret Machine.—W. R. S.' Please tell me how you would suspend the fly-wheel, and what with, and how long the bars of iron are to be, and if they both have to be fastened to a bench, or what. Please attend to it as soon as possible."

Plaster Modelling.—Clerk (*South Shields*).—Papers on modelling in clay will appear shortly; if, however, you refer to gesso work under the name of plaster modelling, an article on this subject appeared in No. 25 of this Magazine.

Hand-Saw Teeth.—A. R. (*Scorrier*) writes:—"In No. 20, page 317 of Work, J. H. writes:—'A. R. (*Scorrier*), before criticising an author, should ascertain his meaning.' Are we to suppose that an author cannot err as well as others? I think all are liable to errors, and shall be pleased at any time I make a mistake to be corrected. J. H. said, in No. 11 of Work, that Fig. 6 (see page 162) represents teeth used in cutting soft wood, but is unfit for general work; herein I think he admits his error. Again, in No. 20 (page 317) he says teeth to cut truly require a good deal of rake; but rake represented in Fig. 6 is unfit for general work. Does not this imply or indicate that it is fit for a certain class of work? and as J. H. wrote in reference to hand saws, I maintain that it is misleading, as such teeth in a hand saw are unfit for general or any other class of work. I hope J. H. will excuse me, as I mean no offence, but if possible would like everything to be made clear in Work."

Powerful Rip Saw (*Highbury, N.*) writes in reply to Artist in Wood (see page 348):—"Being a reader of your paper I notice in No. 22, under head of 'Powerful Rip Saw,' a drawing of a small circular saw, and which I entirely fail to understand, I mean as to how it is to work. I say nothing about the saw itself or the wheels, etc., but what I fail to appreciate is, how is that treadle going to work that saw. The treadle is fixed to a cross bar at the bottom. I can understand that, but where is the necessary leverage coming in so as to make that fly wheel revolve? I mean the rod, D, how is that operated in order to make the necessary motion to this wheel? Taking the drawing as it is, you would think that when the treadle was pressed upon, that the rod, D, would be pulled down by the rod which connects D with the treadle, which rod has no name in your design. There was also another machine, a fret, intended to be of very simple mechanism, but which was as puzzling to myself and to several other parties to whom I showed it, as if it was one of the most complicated machines in existence; in fact it could not work, if the drawing produced in your paper was the correct one and not a mistake. These articles appeared in 'Shop' in your columns."—[You will oblige by sending a sketch of the machine as corrected by yourself.—Ed.]

Timber for Coach Building, etc.—Aye Work Awa' writes to make mention of Messrs. M. M'Neill and Sons, 24, M'Alpine Street, Glasgow, whose

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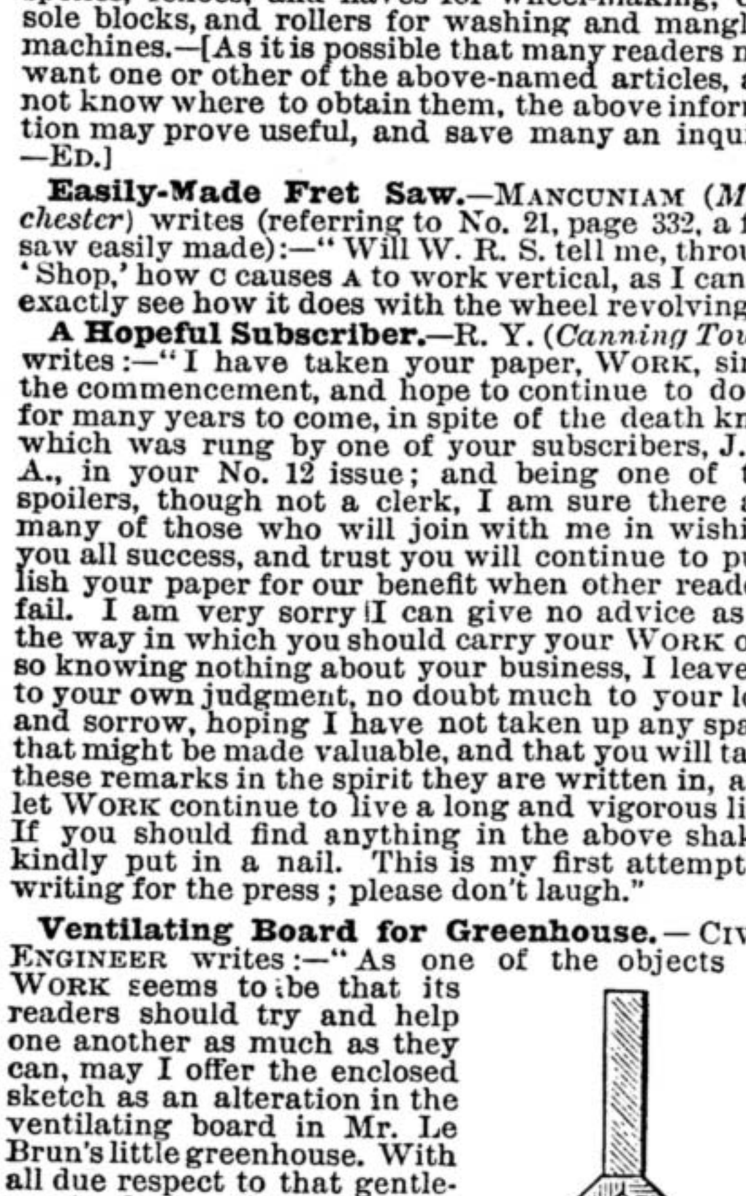
works are at Longford, Killarney, Enniskillen, and Sligo, and of whom North Countrymen may obtain hammer, pick, and shovel handles, round and oval, requisites for cart, coach, van, lorry, and barrow building, railway, pit and waggon wood, barrel staves and heading, home-grown timber, log or sawn scantlings, thread bobbins, or bobbin blocks, carpenter's wedges, oak crooks and bends, shafts, spokes, felloes, and naves for wheel-making, clog sole blocks, and rollers for washing and mangling machines.—[As it is possible that many readers may want one or other of the above-named articles, and not know where to obtain them, the above information may prove useful, and save many an inquiry. —ED.]

Easily-Made Fret Saw.—MANCUNIAM (*Manchester*) writes (referring to No. 21, page 332, a fret saw easily made):—"Will W. R. S. tell me, through 'Shop,' how C causes A to work vertical, as I cannot exactly see how it does with the wheel revolving?"

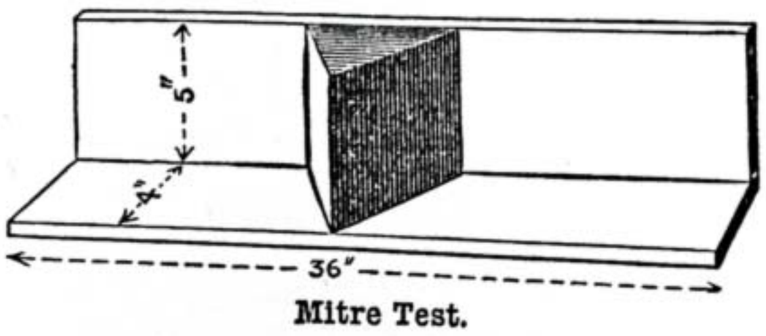
A Hopeful Subscriber.—R. Y. (*Canning Town*) writes:—"I have taken your paper, WORK, since the commencement, and hope to continue to do so for many years to come, in spite of the death knell which was rung by one of your subscribers, J. P. A., in your No. 12 issue; and being one of the spoilers, though not a clerk, I am sure there are many of those who will join with me in wishing you all success, and trust you will continue to publish your paper for our benefit when other readers fail. I am very sorry I can give no advice as to the way in which you should carry your WORK on; so knowing nothing about your business, I leave it to your own judgment, no doubt much to your loss and sorrow, hoping I have not taken up any space that might be made valuable, and that you will take these remarks in the spirit they are written in, and let WORK continue to live a long and vigorous life. If you should find anything in the above shaky, kindly put in a nail. This is my first attempt in writing for the press; please don't laugh."

Ventilating Board for Greenhouse.—CIVIL ENGINEER writes:—"As one of the objects of WORK seems to be that its readers should try and help one another as much as they can, may I offer the enclosed sketch as an alteration in the ventilating board in Mr. Le Brun's little greenhouse. With all due respect to that gentleman's design (for it is both good and pretty), he has shown his board open, and I am afraid as he has it, it would not shut; but if it did, it would leave a very nasty little corner for the rain. The little bit of advice I should like to offer, especially to the amateur readers of WORK, is that, where the rain has to drip, try and make it do so freely; this is often to be done by making the under edges of your work as acute as you can, as in the sketch I send. I trust these few remarks may be of use to some of your readers. I am another who has taken in WORK from the first, and let me wish it all the nice things I see others have wished it, which I will not repeat because of your space."



Arrangement for Ventilating Board.

Mitre Test.—H. M. B. (*Edinburgh*) writes:—"The sketch shows a useful contrivance for testing the mitres of cornice mouldings which are not fully backed up, and which, therefore, cannot be gripped in the mitre trap, or tested with the mitre stock thus:—



Mitre Test.

Two pieces of wood are fixed at right angles with each other, and a half of a square block cut through the diagonal line is fixed in the centre. After cutting the moulding in the mitre box, place the bottom edge of the moulding upon the sole, and keep the back of the moulding firm against the upright, and fit the mitred end close up against the centre block, after which it can be fixed on the job with the assurance of the returns intersecting accurately. The mitres of heavy gilt moulding can also be tested with it."

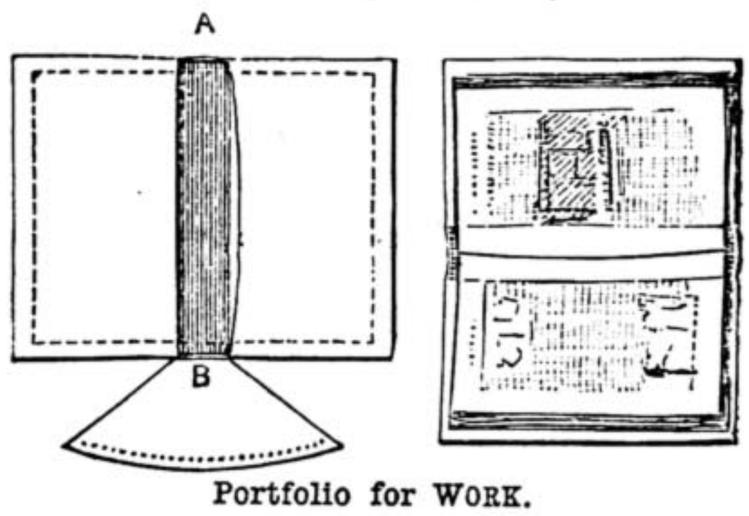
Weight of Fly-Wheel.—J. (*Twerton-on-Avon*) writes in reply to F. C. (see page 284):—"Mr. Campin's criticism of the formula for fly-wheels, given in page 189, is correct in theory. That formula is not strict in theory, neither is it given as fulfilling the requirements of theory, but as a working formula for rough-and-ready practice, and therefore suited for a book of workshop reference, like 'Molesworth.' Many rules in Molesworth, Hutton, and others would not fulfil the requirements of scientific engineering, but practical men find them useful because they give approximations sufficiently good for ordinary work. No one would think of designing the fly-wheel of, say, a mill engine, by such a rule, but it is correct enough for the common practice of makers of small engines used for general purposes—engines which are often run at very variable speeds. Only a few days ago a firm I know bought one of Hindley's engines, which was designed for a speed of 200 revolutions, but they ran at 60, altering the lead of the value to suit. But the fly-wheel is not altered, neither is it necessary to do so. Looking at Molesworth's formula, which is doubtless deduced from practice, and is still retained, in spite of criticism, in the latest, or 21st edition, as in previous ones, the factor N counts for little, because it is divided by 60, so that if the number of revolutions of the engine were 60, N might be struck out. The important factor in this formula is D, the weight varying inversely as D. Again I repeat this is not a perfect formula, but a good one. Because it is not perfect, I gave the correct theory at length in my reply on page 189. Molesworth—invaluable in the factory—contains a collection of rules largely empirical, but embodying good practice, hence the appreciation in which it is held. For nice calculations, requiring a strict adherence to fundamental principles, it is not intended, nor generally adapted."

Rustic Work.—A. R. (*Scorrier*) writes:—"In No. 16 of WORK, pages 248 and 249, there are designs of rustic work which, I am sure, should please all readers of WORK; not only so, but the very plain and able way the writer has given instructions how to proceed with the work is worthy of praise. In fact, I was so pleased with the writer's description of rustic work, that I read it over three or four times, and before I finished reading I had the porch and fence made without nails, hammer, or even a hand-saw, and felt only too sorry that I was not in possession of a good garden wherein to erect it. If everything in WORK is made so plain to the mind as the remarks on rustic work, the most simple may not err; and there will be no need of readers saying there is more talk than work in WORK. Again, I see some of our readers wish WORK to be enlarged, but there are two sides to everything; those that want a larger paper may have a lot of spare time, while many a working man, for whom I presume WORK is chiefly intended, will find there is quite enough in WORK at its present size to peruse in the little spare time he has in a week. Again, many an amateur and poor man will put a penny a week in a paper when they would not spend threepence. Therefore, I think it would be decidedly wrong to deprive the poor man of his little pleasure and instruction to oblige a few that have time and money to seek other pleasure after they have read the pages of WORK."—[There is not the slightest idea of raising the price of WORK. It is meant to be a poor man's pennyworth. Please send your name and address.—ED.]

Saws.—W. O. S. (*Manchester*) writes:—"I should be much obliged if one of your contributors could inform me as to the price of a saw suitable for comparatively heavy work such as sawing rough trunks of trees, either with or against the grain. The width of the key would not be a matter of much moment so that it cut rapidly. When I say tree trunks I don't, of course, mean large timber, but the trees which people frequently cut down for themselves in gardens where the size of the trunk is not, as a rule, over 8 in. or 9 in. Also the name of the maker, and probable price."—[The best saws for your purpose are—the one man cross-cut saw, 3 ft., 7s.; 3 ft. 6 in., 8s. 3d.; 4 ft., 9s. 9d.; 4 ft. 6 in., 11s. 3d. each; and the same perforated, to assist in re-gulleting, 3 ft., 8s. 9d.; 3 ft. 6 in., 9s. 9d.; 4 ft., 11s. 3d.; 4 ft. 6 in., 12s. 9d. Sold by Melhuish's, Fetter Lane, Holborn Circus, E.C.—ED.]

Subjects in WORK.—FRISBY writes:—"I have been a subscriber to your valuable Magazine, WORK, ever since it started, and as an amateur wood worker (or, as I have seen it put by one of your correspondents, wood spoiler) I have gained some valuable knowledge from it, and the simple practical way of explaining the work that is touched on in it has helped me much. While I have failed to find that those articles which are complained of by W. V. C. are written far above one's head, I have noticed that the writers of some of the papers have not followed out that simplicity in which Mr. Adamson set such a good example in his articles on the Screen Secretaire; for instance, the article on Soldering, in my opinion, might have been improved much by the addition of a word or two more in explaining Figs. 9 and 10—home-made gas stove and gas stove cover. This is only my opinion, mind. Of course you have to study economy in regard to space; and yet I see some are trying to intrude on our valuable space by inducing you to start a series of designs for a cottage first, and gradually go on to the mansion. Now, Sir, if I understand WORK rightly, it is to fill a gap, or, in other words, to treat that which other periodicals have never treated; and it cannot be said that designs for every class of dwellings, from the four-roomed cottage to the mansion, have lacked treatment or publication. Therefore, if WORK takes up this to oblige those few to whom it might be of some use, it would, in my opinion, be at once departing from its original purpose. Much might be said on both sides, no doubt, but it is needless, as the editor, to my mind, does not seem likely to yield too much to the opinions and advice of those who write to him, although he may seek to satisfy them, as far as he can do so, without abandoning his own opinion as to what may be expedient for the well-being and success of the Magazine."—[Your letter is precisely in accord with what I have been seeking to explain to my readers all along—namely, that if a paper be ever so good, there will be some to whom it may not appear entirely satisfactory. Everybody concerned in the production of WORK has done, does, and will do, their utmost to put forth in its pages that which will be generally useful and instructive. Of course every writer is pleased to know that his paper has given satisfaction, but most of them, I imagine, are like myself, tolerably pachydermatous, and very little disposed to be puffed-up with praise or depressed by strictures.—ED.]

Portfolio for WORK.—E. H. R. (*Edinburgh*) writes:—"In 'Shop' (No. 13) correspondence, I observe a portfolio for weekly numbers of WORK, which is very good, and I am glad to see some one as careful as myself in making something to preserve WORK, as it is well worthy of it. The way I have made my folio is simply this: Get two pieces of stout yellow straw board, 1 in. larger each way than your paper, that will give you ½ in. all round, which is plenty of protection, and a strip of American cloth, or as I have used, prepared artist's canvas 3 in. broad and 4 in. longer than your boards. Now use strong glue, and glue your piece of canvas all over on the unprepared side, laying it before you, glued side up; now attach your boards, taking ¾ in. of a catch, and you find 2 in. projecting at each end, which you will find of great advantage, as it is in these parts the strength of your work lies. Simply turn them in, and adhere them with glue. Now get another strip of calico the same breadth as your canvas or American cloth, and ½ in. less than the length of your boards for the inside of your folio; this strip of calico I would advise you to put on with strong paste, as it will make a cleaner job, and although it takes longer to dry it stands better, as it keeps the glue from cracking when you combine it with paste. This being done, having seen to everything being square, cut clean and well put together, lay flat out on a table, and put a slight weight on it overnight; next day take it out and have a look at it, when it will present a pleasing aspect. Now, the next thing to be done is the way I have done my own, which is as simple as A B C, and of which



Portfolio for WORK.

I will draw you a sketch that you may understand it. As there will be fifty-two parts for the year we must make provision for them. The method I have taken is to get a needle and a ball of small but strong twine, and thread my needle with a very long double thread of it. Now I commence by dividing A and B into twenty-six equal parts with a pair of dividers, or what is often called compasses. As twenty-six is the half of fifty-two, and I have a double thread, so I set to sewing, passing my needle through the marks I have made with my dividers. I commence at A and go down to B, and from B back again to A, and so on, until I have completed my twenty-six double strings, and now my folio is nearly ready for its work. You will now see where your doubled parts of canvas are of use, as they contain all the stitches, and bear all the strain. Of course you might want your book to look better outside; but this I leave to your own good taste. I find this style of folio very useful, as it can be filled or emptied as you may want it. If Vol. 1 is completed send it to the binding, and your same folio is ready for Vol. 2. Another advantage is when you get your part before you can manage to read it it must be cut up, and by doing so every leaf is loose; to avoid them from being lost, many people stick a pin through the centre, which is not only ugly and marks the paper, but if not put with its nose inside, it is apt to prick your fingers, and suddenly reminds you that it's there. I require nothing of this kind: my folio supplies it, and keeps all together compact and neat, and I can have the full year's volume in my hand without inconvenience, if at any time I want to refer to anything in WORK or 'Shop.' The cuts given above will, I think, fully illustrate my meaning."

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II.—QUESTIONS ANSWERED BY EDITOR AND STAFF.

Banjo.—W. H. B. (*Leicester*).—Instructions in banjo making shall be given at some future time, but they must be kept in abeyance for the present. As you are just completing one you will hardly require them yourself, but you ask for them considerately for the good of others.

A Clock that Never Requires Winding Up.—COTTAGER.—Thank you very much, but I really do not wish to see the diagram of the works of the clock that will never run down. If your ideas were "both feasible and practicable," you would have solved the problem of perpetual motion, which has been exercising the minds of many men from generation to generation for a long string of centuries. You say:—"If I receive no answer, I shall come to the conclusion that this theory of perpetual motion is also a failure. Any advice you may be pleased to give will be thankfully received." I endeavour to have every query answered either by my staff or myself, and to leave no applicant unanswered. The only advice I can give under the circumstances is to turn from the impracticable to the practicable, and endeavour to use your inventive powers in working out something that will be really useful and helpful to those of your generation.

Barometer Tube.—W. M. (*Belfast*).—The air bubbles got into your barometer tube whilst being shaken in process of removal. Although the tube was corked, this did not prevent ingress of air to the mercury, and the shaking caused some air to pass the agitated particles of quicksilver to the closed end of the tube. The tube will have to be removed, gently warmed, and shaken, as directed in my reply to BAROMETER, F.B., in "Shop," p. 158, No. 10.—G. E. B.

Magic Lantern.—J. H. J. J. (*Birmingham*).—The dimensions of a full size lantern are as follows:—Height, 13 inches; width, 6 or 7 inches; and depth front to back, 9 inches. These are about the measurements of Mr. Julian's lantern when turned on its end. To have it 11¼ inches long is a disadvantage, as the light and reflector are too far away from the lenses, which should not be more than 6 in. focus, as longer focus will involve a loss of light, and shorter will endanger the lenses from the heat. Over the ventilating holes in the sides a false bottom must be soldered, which must be pierced with holes for ventilation. And it will be better if there is a sliding tray on the bottom (with a handle projecting through the back) to hold the lamp; by this means the lamp may be moved nearer to or farther from the lens without opening the door. Mr. Lancaster, of Colemore Row, Birmingham, will supply a set of lens, consisting of two for condensers, and two for the front. For anything like practical work not less than 3½ in. condensers should be used; these with front lenses can be had from Mr. Lancaster for 12s. 6d., or 3 in. for 8s. 6d. Measure the thickness of the two condensing lenses, and make a tin or brass tube large enough to take them easily, and ¼ in. longer than they are thick. On the inside at one end solder a ring of wire (Fig. 1) to form a bed, against which

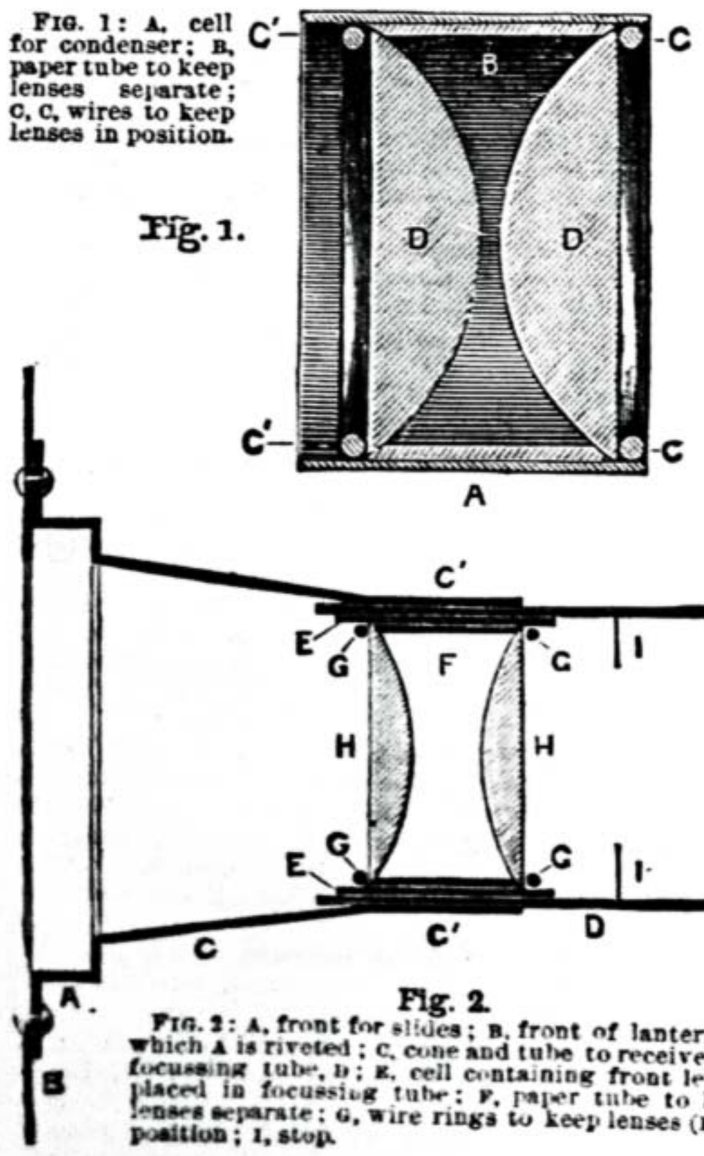


FIG. 1: A, cell for condenser; B, paper tube to keep lenses separate; C, C, wires to keep lenses in position.

Fig. 1.

Fig. 2.

FIG. 2: A, front for slides; B, front of lantern to which A is riveted; C, cone and tube to receive the focussing tube, D; E, cell containing front lenses placed in focussing tube; F, paper tube to keep lenses separate; G, wire rings to keep lenses (H) in position; I, stop.

one of the lenses may rest. Now make a hoop, B, of stout cardboard to fit the cell, and to rest on the first lens, and of such a width that when the other condenser is placed in the cell they shall be separated about ¼ or ⅓ in. Care must be taken that the ends of the cell and paper tube are square and true, as the lenses must be perfectly parallel with each other. When they are properly adjusted a ring of stout brass wire, C, must be sprung into the cell, so as to keep the lenses in position (Fig. 1). Next a tube or collar large enough to take the cell, and hold it firmly, must be soldered on the inside of the front, or better still, if made with a flange and riveted. In fixing this collar great care must be observed, so that it be concentric with the opening for the focussing lenses. A cone must now be made to carry the focussing tube, which must be 4½ in. long, 3½ in. at the large end, and 2¼ in. at the small. It will be best to make a paper pattern first thus: On a sheet of paper strike an arc of 13 in. radius. Bring the pencil 4½ in. near the centre, and strike another arc. From the centre draw a line cutting the two arcs. From the point where the line cuts the larger arc, mark off 11 in., and from this draw another line to the centre. Cut out the piece between the two lines and curves, and we shall have a pattern of the cone. In cutting the tin plate leave ¼ in. on one side for overlapping the joint. If this is done properly we shall have a cone whose axis will be perpendicular to its base. Make a tube 2 in. long to C, fit the small end of the cone, and solder it perfectly perpendicular with it. The cone must now be soldered to the gallery for carrying the slides, and is known as the "front." A tube, D, 4 in. long, must now be made to fit the front, into which the front lenses must be fixed in a cell in a manner similar to that already described. These lenses must be ½ in. apart. Although for convenience of description we have mentioned this cell last, it must be made first and the tubes made to fit it. Sometimes amateurs find it convenient to procure parts already made. Mr. L. meets these cases, and supplies fronts with springs at 5s. I have overlooked the fact that a "stop" must be placed in front of the front lens with a central hole 1½ in. diameter (see Fig. 2). A lamp and reflector will, of course, be required. These are supplied for about 10s.; a treble refulgent patent lamp at 16s. 6d. When making the first attempt at exhibiting both the lamp and focussing tube will require adjusting. If the light is uneven move the lamp nearer to or farther from the lens to one side or the other, until the disc is uniformly illumined, and then adjust the focussing tube until the picture is crisp. It will be well to light the lamp for some little time before exhibiting, that the oil may be warmed, and so flow the better. The wick should not be turned up too high to commence with, else it becomes charred. With such a lantern certainly interesting exhibitions may be made; the inside of lantern and tubes must be blackened.

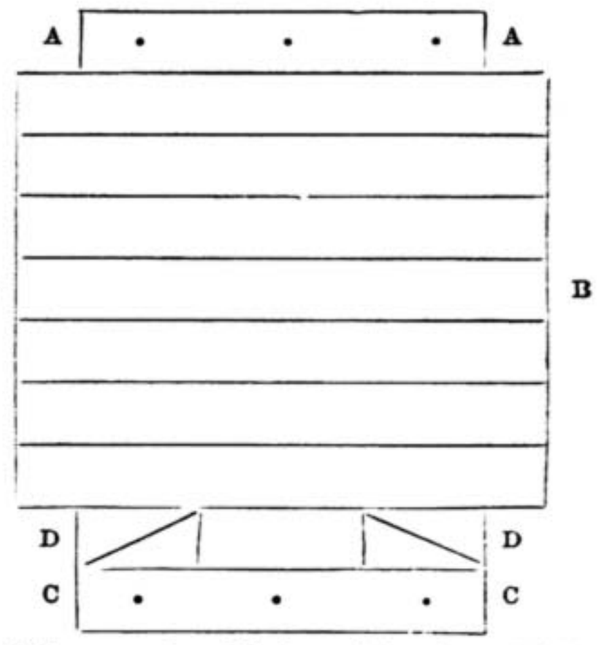
Enamel Paint.—W. H. D. (*Liverpool*).—I am afraid your difficulty in applying this must be owing to your having used an unsuitable brush. The paint being stiff you should use a hard brush. The less turpentine you use the better, though it ought not to change the colour. Of course, I am supposing that the turpentine you use is colourless. The wood should have been sized before painting, though four coats of paint should give a good ground. It is not necessary to rub down with pumice powder. The paint should dry glossy, and I can only suppose as it does not, and there is not sufficient body, that you have used too much turpentine. If you do not like the enamel paint you name, try the Falcon brand, which is made in your city.—D. A.

Gilding Fretwork.—W. H. D. (*Liverpool*).—You may do as you suggest, but it is not necessary. A better plan is to go over the parts to be gilded with one coat of gold size. As soon as this is "tacky," apply the leaf. Defects can then be remedied by going over any places to which the gold may not have adhered. A good deal, of course, depends on the kind of wood used. If the size is quite absorbed, you have no alternative but to repeat the sizing.—D. A.

Ebonising Wood.—W. H. D. (*Liverpool*).—Get your stain ready made, as you will do better than by preparing it yourself; Minton's, Manchester Street, is a good place. Wash the stain into the wood to be ebonised. When dry, if not black enough, repeat the operation; but remember that the stained wood when dry does not look so black as it will when polished. Proceed as in ordinary French polished work, adding a little gas black to the polish. Finish up as usual, and if "dull polish" is wanted, deaden the gloss by dusting on a small quantity of finest emery powder. Rub this on lightly with a brush or soft cloth, and take care that you rub evenly in the direction of the grain. Any wood can be ebonised. Bay wood, walnut (American), beech, and American white wood are generally used.—D. A.

Mounting Calendars.—AN OLD GLUER says:—"I am employed by a firm for mounting calendars, and each stick I have to glue one by one, and I have some thousands upon thousands in the course of the season. Could you kindly inform me if there is a machine for gluing the sticks, so as to save time and labour?"

[In reply to your appeal I can only say that I do not think there is any machine for the performance of work of this kind. If you could manage to place a number of the sticks—presuming they are flat sticks—together on a piece of board, so that the surfaces to be glued would form, as it were, one piece or plane, you might rub the brush over a good many at one and the same time. You would have to place the first stick against a fence or slip of wood screwed along one edge of the board, and then, when the last of the number was placed in position, tighten them up by a movable fence at the opposite edge actuated by a screw; or you might have both fences fixed, and tighten up by the action of reversed wedges. The annexed diagram will give



Contrivance for Gluing Calendar Sticks.

you an idea of my meaning:—A, A, is first fence fastened down to board; B, B, are the sticks; C, C, is the opposite fence, also fastened down to board; D, D, are two pairs of wedges driven in contrary direction, so as to clamp up the sticks, B, B.]

Choosing a Trade, etc.—EXCELSIOR.—To commence with, I think I had better give your letter in full:—"Will you kindly inform me if it is possible for a person to learn a trade without serving an apprenticeship—that is, by devoting three hours a day in working out the instruction given in books or journals like WORK? I am twenty-five years of age, and am very anxious to learn a trade, but I have not the means to apprentice myself, so I am taking the liberty to ask you, Sir, if you will kindly single out a trade which I can learn in the way that I have mentioned. What would you say about house painting or furniture polishing? Of course, I could practise these trades on my own house and furniture—but, there, I shall leave the matter in your hands, wishing you and your magnificent journal 'God-speed!'"—The difficulty, perhaps impossibility, of living while you are learning a trade apparently stops the way. To gain practice, you require to work at a trade from morning to night; but you can only devote three hours a day to practical work after the real business of the day is done. With regard to the choice of a trade, that must be left to yourself. If I could see you I could hear all you have to say, and advise you accordingly. I might suggest a trade for which you have a distaste—chimney sweeping, for example. I say this in order to show how difficult and even dangerous it is to attempt to choose for another without special knowledge of the person for whom the choice is to be made. You seem to gravitate towards painting and French polishing, which, roughly speaking, is decorative work. I see no reason why you should not follow this up if you have an inclination for it; but here a difficulty confronts you in the want of things to paint and polish. I myself should prefer carpentry and cabinet making: and my reasons are these:—(1) That if you have means of exposing for sale articles you have made, there are many things useful and ornamental which you could make at small cost during the three hours daily that you allot yourself for learning. (2) Carpentry is a clean trade, and can be put aside at a moment's notice; but this cannot be done in painting and polishing, or, at least, not done conveniently. But whatever trade you may choose, my advice to you generally would be, first to settle on a trade for yourself; then to make up your mind to devote your whole time and energies to the work, whatever it may be: and, thirdly, having done this, to seek some one in the same trade and endeavour to make an arrangement with him to pay you enough to keep body and soul together in exchange for your services while you are learning your trade. I can see no other way of bridging the gulf that lies between your present occupation and that which you wish to adopt. If possible, the tradesman to whom you hire yourself should be a friend, and one who would be in no way disposed to take advantage of you during the transition stage.

Coach Painting.—F. S. B. (*Bradford-on-Avon*).—A good practical work on coach painting, and things connected with it, is "Coach Painting," by Arlot, 6s., Spon & Co., 125, Strand, London, W.C. The subject, however, will be fully treated in the papers to appear in WORK on all branches of carriage building.

Plaster Casts.—J. S. (*Eastwood, Notts*) may obtain floral and ornamental casts, and, indeed, almost anything that is made in plaster of Paris, from Messrs. D. Brucciani & Co., 40, Russell Street, Covent Garden, London, W.C., at whose shop he will probably find the largest variety of such wares to be met with in England.—M. M.

Step Chair.—F. J. C. (*Brockley*).—A correspondent is at work on an article describing the step chair and its construction. You may rest assured that the index to contents issued with each yearly volume will be as complete as it is possible to make it.

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III.—QUESTIONS SUBMITTED TO CORRESPONDENTS.

Machine for Current of Air.—A. S. (*Liverpool*) writes:—"In respect to A. H.'s (*Wolverhampton*) reply to BELLOWS (*Gloucester*) in WORK for 27th of July, regarding a machine for current of air, I hope A. H. will be so kind as to give dimensions and diameter of pulleys to drive this machine that will answer for an amateur forge, and hints on constructing a cheap hearth for the above pattern of fan, and the mode of fitting water to run about the mouth of pipe that carries the air from machine to the hearth. Pardon me, Sir, in asking these particulars from you. Be as precise as you can, and plain, as I can see it is a good thing for amateurs. In answering questions of this description we can't be too plain."

Tondeur Photographic Developer.—E. L. H. (*Begbroke, near Oxford*) will be obliged to any reader who will give him the formula for the Tondeur Photographic Developer.

IV.—QUESTIONS ANSWERED BY CORRESPONDENTS.

Paint on Leather.—T. C. C. writes in answer to J. B. S. (*Nottingham*) (see page 318):—"If the leather to be lettered is dressed with grease, the best way would be to scrape the surface with a pointed knife before applying the paint, or use turpentine, which will kill the grease; then the letters would not chip off."

Sheet Metal Book.—W. H. W. (*Seedley*) writes:—"I see in No. 20 of WORK that ST. MUNGO would desire to know the name of some book to assist him in sheet metal work. I, being a journeyman tinman, think that the book published by H. Warne, entitled 'Metal Plate Work,' would suit him, as it gives the patterns for baths and aquariums, the price being 10s. There is a very good one by J. Millas among the technical school series, price 6s. 9d., but Warne's would be the best for our friend. I suppose your correspondent will be able to manipulate the article after being shown the pattern, and having read Mr. Alexander's simple yet efficient paper on the metal plate subject."

Cleaning Oil Paintings.—H. G. (*Liverpool*) writes in reply to L. S. (*Lower Broughton*) (see page 190):—"Take the picture out of its frame, place it flat upon a table, face uppermost. Next provide two clean bottles, and a quantity of raw cotton wool. Place in one bottle sufficient spirits of wine of an ascertained strength of 58°, reduce by adding one-fourth part of spirits of turpentine; shake well, to thoroughly mix. Place in the other bottle a sufficient quantity of spirits of turpentine alone. Having the picture lying flat upon a table before you, and in a good light, proceed by taking in the right hand a small tuft of the raw cotton wool, slightly wetted with the mixture from the first bottle, which must be well shaken each time a fresh supply is required to moisten the cotton. Then take another tuft of cotton in the left hand, slightly wetted with the spirits of turpentine from the second bottle. Commence to clean by lightly rubbing the figure with a circular motion with the tuft of cotton in the right hand, examining the cotton every minute or so to see that none of the colour is being removed. When the figure is thoroughly cleaned, wipe it over lightly with the tuft of cotton held in the left hand and moistened with the spirits of turpentine alone. Repeat this process until the entire surface of the picture is quite clean. Care must be taken to change the cotton wool frequently, so that none but clean wool is brought in contact with the picture. When all the varnish has been removed the picture should be quite clean, and only requires to be revarnished. The greatest possible care must be used in passing over the shadows in the picture, which are produced by very thin painting and glazing, and if the tuft of wool in the right hand should show the slightest appearance of colour other than that of the varnish, which is usually of a faint yellow tint, the tuft of cotton in the left hand (moistened with the spirits of turpentine alone) should be applied at once, to prevent any further dislodgment of colour. If the picture in question is faded in any degree, it may be beautifully restored by being exposed to a strong sunlight for two or three months, when it may be revarnished with the greatest safety. To revarnish a picture, place a bowl or jampot in a bowl of boiling water. Pour into the jampot one-third of spirits of turpentine, and two-thirds of mastic varnish, mix thoroughly until a vapour arises from the mixture. Varnish the picture with this preparation as thinly as possible, applying the brush briskly until the entire surface is evenly covered with a very thin coat. This may be repeated two or three times, or until it gives complete satisfaction. Your correspondent should be recommended to consider well before he commences to clean his picture. None but those possessing a considerable knowledge of painting, and having considerable experience in cleaning, should attempt to restore or clean a work of any value. If considered of moment you may furnish your correspondent with my address, and I shall be very pleased to send him further information."

Dulcimer.—ALPHA writes:—"I see a CORRESPONDENT (see page 206) asks for a few hints on making a wooden dulcimer. I have one a wood frame, and strung with wires. I append a rough drawing (Fig. 1), showing general appearance and section. I hope it is what is needed. It is 1 ft. 3 in. long at top, and 3 ft. 2 in. long at bottom; the side is 1 ft. 8 in. long, and 3¾ in. wide by 4 in. deep; the top and bottom are made out of inch stuff 4 in. wide; of course, it is 4 in. deep all round, so the sides will be 4 in. by 4 in. The back is made out of 1 in. stuff; the middle piece put in to support the bridge is 1 in. thick, and the sounding-board rests on it; the sides have a slip of sycamore jointed to them 1 in. thick to hold the pins, and tightening pegs which are of iron; the

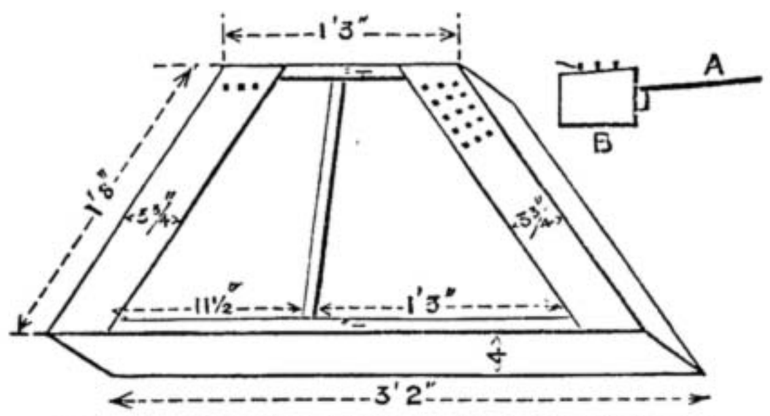

Fig. 1.—General Appearance of Dulcimer.

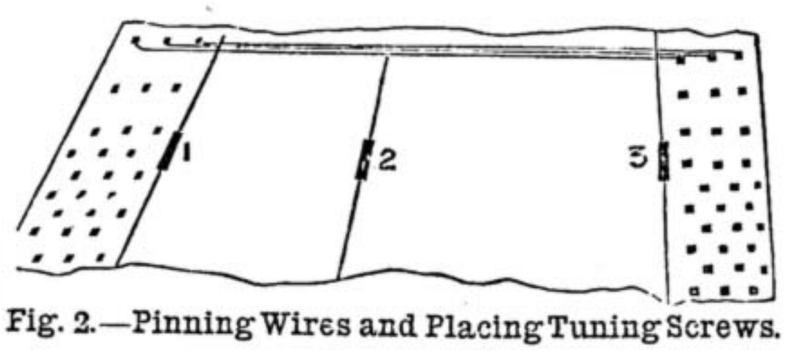

Fig. 2.—Pinning Wires and Placing Tuning Screws.

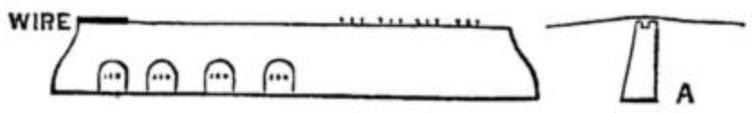

Fig. 3.—Construction of Bridge.

sounding-board is of mahogany ¼ in. thick. Fig. 2 represents how the wires are pinned and tuning screws are placed. There are fourteen notes of three wires each going over the bridge and seven going under the bridge. 1, 2, 3 are ⅛ in. wire, so that the sounding wires will not cut into the wood. Fig. 3 shows how the bridge is constructed. It is made of ebony an inch deep, about ¾ in. at bottom, and ⅜ in. at top: keep the sounding-board high enough so that the bridge will not touch the wires. It is all pine except what I have mentioned, which can be stained and veneered to suit.

Sloping Boxes and Hoppers.—B. A. B. writes in reply to X. Y. Z. and others:—"The directions given on page 173 give the angle of the edges, and of the mitre or butt joints drawn thereon, but the principal difficulty remains unexplained. It is, however, quite simple when studied for a little while. Let A B C in the figure be the angle as drawn on the elevation. We want to find the angle to cut our boards; we can obtain this in various ways. Let one be sufficient. From point B describe arc of circle having radius B C; then draw the line, D H, through the arc parallel to A B; from the line A B to the line D H is the width of the board required (after edges have been planed to the angle A B C); the angle can be had by drawing a line from C to E perpendicular; to line D H join E B. E B A is the correct angle for boards; this needs no proof, it is obvious. The

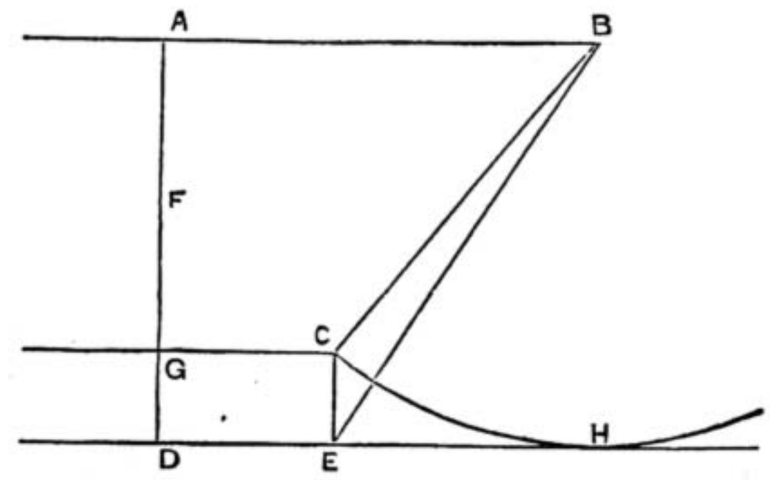

Diagram showing Mode of finding Angle at which to cut Boards.

side board being wider than the length of a perpendicular dropped from B to the base line, and it being as necessary for the bottom to be the correct dimensions, E must be equidistant, as C, from an imaginary perpendicular line—say F; therefore the angle A B C drawn on the elevation becomes the angle A B E drawn on the sloping sides. Let the querist draw on paper a parallelogram, or a square, representing the top of the box; at a distance equal to the width of sides, B C in the figure, and parallel to the representation of top, draw to same scale representation of bottom; draw centre line through both, cut out and fold, so that centre line lies in one plane, and he will at once understand the whole subject. In the diagram A B represents top edge of hopper, C G, the bottom edge, and B C, side, all in elevation; width of side B C is set off to H, as shown by arcs; draw line C E at right angles to G C; the angle to cut sides is then shown in E B A.

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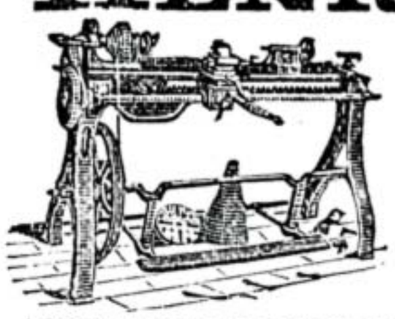

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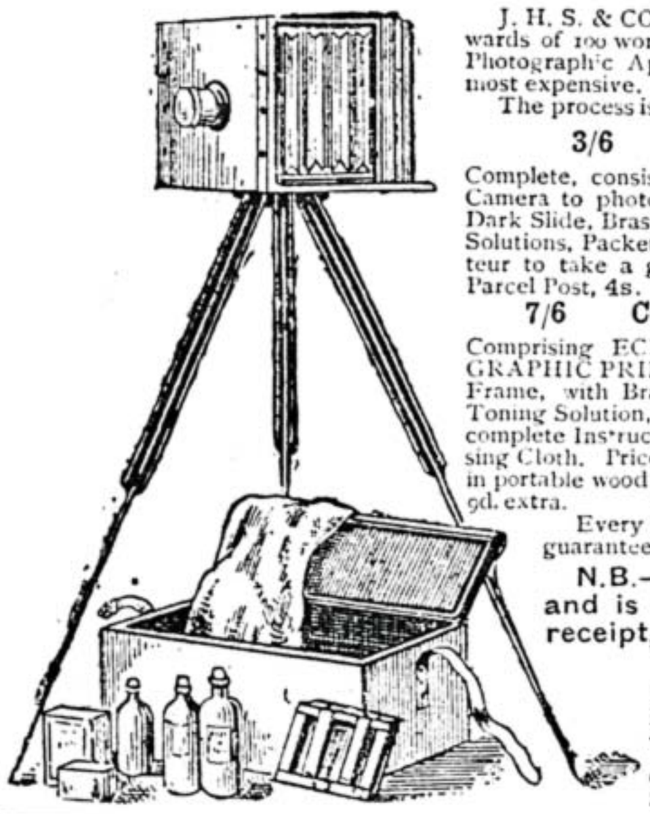

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